

SBE 37-SM MicroCAT

*Conductivity and Temperature Recorder
with RS-232 Interface*



***Shown with standard titanium housing;
optional ShallowCAT plastic housing available***

User's Manual

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**Manual Version #026, 06/14/07
Firmware Version 2.6b and later**

Limited Liability Statement

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Section 1: Introduction

This section includes contact information, Quick Start procedure, photos of a standard MicroCAT shipment, and shipping precautions.

About this Manual

This manual is to be used with the SBE 37-SM MicroCAT Conductivity and Temperature Recorder (pressure optional) with **RS-232** interface.

It is organized to guide the user from installation through operation and data collection. We've included detailed specifications, command descriptions, maintenance and calibration information, and helpful notes throughout the manual.

Sea-Bird welcomes suggestions for new features and enhancements of our products and/or documentation. Please e-mail any comments or suggestions to seabird@seabird.com.

How to Contact Sea-Bird

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Except from April to October, when we are on 'summer time'
(1500 to 0000 Universal Time)

Quick Start

Follow these steps to get a Quick Start using the MicroCAT.
The manual provides step-by-step details for performing each task:

1. Install batteries and test power and communications (*Section 3: Preparing MicroCAT for Deployment*).
2. Deploy the MicroCAT (*Section 4: Deploying and Operating MicroCAT*):
 - A. Install new batteries if necessary.
 - B. Ensure all data has been uploaded, and then set **SampleNum=0** to make entire memory available for recording if desired.
 - C. Set date and then time.
 - D. Establish setup and logging parameters.
 - E. Set MicroCAT to start logging now or in the future.
 - F. Remove protective plugs from anti-foulant device cups, and verify AF24173 Anti-Foulant Devices are installed. Leave protective plugs off for deployment.
 - G. Install dummy plug or cable connector, and locking sleeve.
 - H. Deploy MicroCAT, using Sea-Bird or customer-supplied hardware.

Unpacking MicroCAT

Shown below is a typical MicroCAT shipment.



SBE 37-SM MicroCAT



Batteries



I/O Cable



25-pin to 9-pin adapter
(for use with computer
with DB-25 connector)



Spare hardware
and o-ring kit



Cell cleaning solution
(Triton-X)



MicroCAT User Manual



Software, and Electronic Copies of
Software Manuals and User Manual

Shipping Precautions



Batteries packed in heat-sealed plastic; Sea-Bird then places batteries in bubble-wrap outer sleeve and strong packaging for shipment



Assembled battery pack

WARNING!
Do not ship assembled battery pack by commercial aircraft.

Note:

All setup information is preserved in EEPROM when the batteries are removed.

Note:

Batteries must be removed before returning the instrument to Sea-Bird. Do not return used batteries to Sea-Bird when shipping the MicroCAT for repair.

The MicroCAT was shipped from the factory with the batteries packaged separately within the shipping box (not inside the MicroCAT). When packaged in the manner shown and described at left, the batteries are **not** considered Dangerous/Hazardous Goods, and may be shipped via commercial aircraft (those governed by DOT or IATA, including passenger airlines, or cargo carriers such as FedEx, DHL, UPS, etc.) if no more than the number of batteries required to operate the instrument are included in the shipment (i.e., no spares are included).

IMPORTANT NOTE:

Do not ship the assembled battery pack by commercial aircraft. Refer to *Lithium Battery Shipping Guidelines* for background information on the applicable regulations as well as Sea-Bird's interpretation of those regulations, how they apply to the batteries in our equipment, and how we package and label our equipment.

Before attempting to communicate with the MicroCAT, the batteries must be installed following the instructions in *Section 3: Preparing MicroCAT for Deployment*.

If you will re-ship the MicroCAT by commercial aircraft after you have finished testing:

1. Remove the battery pack assembly from the MicroCAT.
2. Remove the batteries from the battery pack assembly.
3. Pack the batteries separately as described in *Lithium Battery Shipping Guidelines*.

Section 2: Description of MicroCAT

This section describes the functions and features of the SBE 37-SM MicroCAT, including specifications, dimensions, end cap connectors, sample timing, battery endurance, and optional external power.

System Description



Standard
titanium
housing

Optional
plastic
ShallowCAT
housing

The SBE 37-SM MicroCAT is a high-accuracy conductivity and temperature recorder (pressure optional) with internal battery and non-volatile memory, and a standard RS-232 serial interface. Designed for moorings and other long-duration, fixed-site deployments, MicroCATs have non-corroding titanium housings rated for operation to 7000 meters (23,000 feet) or pressure sensor full-scale range. An optional plastic *ShallowCAT* housing rated for 250 meters (820 feet) is also available.

Communication with the MicroCAT is over an internal, 3-wire, RS-232C link. Over 50 different commands can be sent to the MicroCAT to provide status display, data acquisition setup, data retrieval, and diagnostic tests. User-selectable operating modes include:

- **Autonomous sampling** – At pre-programmed intervals, the MicroCAT wakes up, samples, stores data in its FLASH memory, and goes to sleep. If desired, real-time data can also be transmitted.
- **Polled sampling** – On command, the MicroCAT takes one sample and transmits the data. Polled sampling is useful for integrating the MicroCAT with satellite, radio, or wire telemetry equipment.
- **Serial line sync** – In response to a pulse on the serial line, the MicroCAT wakes up, samples, transmits real-time data, and goes to sleep. This provides an easy method for synchronizing MicroCAT sampling with other instruments such as Acoustic Doppler Current Profilers (ADCPs) or current meters, without drawing on their battery or memory resources.

The MicroCAT can be deployed in two ways:

- **Cable installed** – The MicroCAT can be remotely controlled, allowing for polled sampling or serial line sync, or for periodic requests of data from the MicroCAT memory. If desired, data can be periodically uploaded while the MicroCAT remains deployed.
- **Dummy plug installed** – The MicroCAT cannot be remotely controlled. Autonomous sampling is programmed before deployment, and data is uploaded after recovery.

Calibration coefficients stored in EEPROM allow the MicroCAT to transmit data in engineering units. The MicroCAT retains the temperature and conductivity sensors used in the SBE 16 SEACAT C-T Recorder, but has improved acquisition electronics that increase accuracy and resolution, and lower power consumption. The MicroCAT's aged and pressure-protected thermistor has a long history of exceptional accuracy and stability (typical drift is less than 0.002 °C per year). Electrical isolation of the conductivity electronics eliminates any possibility of ground-loop noise.

The MicroCAT's internal-field conductivity cell is immune to proximity errors and unaffected by external fouling. A plastic cup with threaded cover at each end of the cell retains the expendable AF24173 Anti-Foulant Device.

The MicroCAT's optional pressure sensor, developed by Druck, Inc., has a superior new design that is entirely different from conventional 'silicon' types in which the deflection of a metallic diaphragm is detected by epoxy-bonded silicon strain gauges. The Druck sensor employs a micro-machined *silicon diaphragm* into which the strain elements are implanted using semiconductor fabrication techniques. Unlike metal diaphragms, silicon's crystal structure is perfectly elastic, so the sensor is essentially free of pressure hysteresis. Compensation of the temperature influence on pressure offset and scale is performed by the SBE MicroCAT's CPU.

Notes:

- Help files provide detailed information on the use of SEATERM and SBE Data Processing.
- A separate software manual on CD-ROM contains detailed information on the setup and use of SBE Data Processing.

The MicroCAT is supplied with a powerful Win 2000/XP software package, SEASOFT[®]-Win32, which includes:

- **SEATERM** –terminal program for easy communication and data retrieval.
- **SBE Data Processing** - program for calculation and plotting of conductivity, temperature, pressure (optional), and derived variables such as salinity and sound velocity.

Specifications

Note:

Pressure ranges are expressed in meters of deployment depth capability.

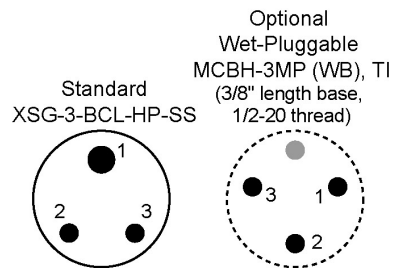
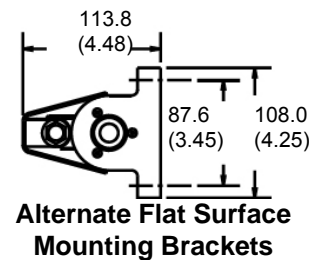
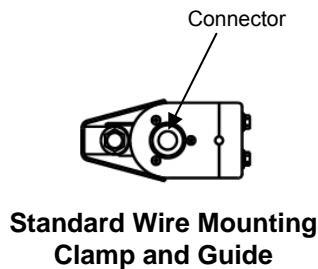
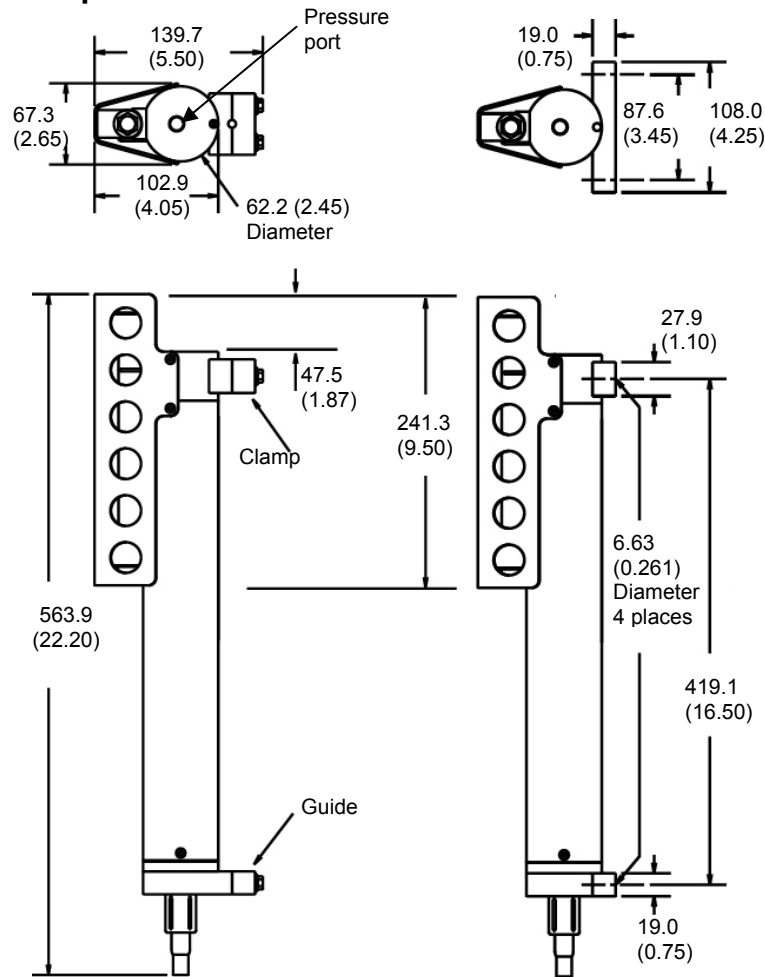
	Temperature (°C)	Conductivity (S/m)	Optional Pressure										
Measurement Range	-5 to +35	0 to 7 (0 to 70 mS/cm)	0 to full scale range: 20 / 100 / 350 / 600 / 1000 / 2000 / 3500 / 7000 meters										
Initial Accuracy	0.002	0.0003 (0.003 mS/cm)	0.1% of full scale range										
Typical Stability (per month)	0.0002	0.0003 (0.003 mS/cm)	0.004% of full scale range										
Resolution	0.0001	0.00001 (0.0001 mS/cm)	0.002% of full scale range										
Sensor Calibration	+1 to +32	0 to 6; physical calibration over range 2.6 to 6 S/m, plus zero conductivity (air)	Ambient pressure to full scale range in 5 steps										
Counter Time-Base	Quartz TCXO, ±2 ppm per year aging; ±5 ppm vs. temperature (-5 to +30 °C)												
Memory	2048K byte non-volatile FLASH memory												
Data Storage	<div>Converted temperature and conductivity: 5 bytes per sample (2.5 bytes each). Time: 4 bytes per sample. Pressure (optional): 2 bytes per sample.</div> <table><thead><tr><th>Recorded Parameters</th><th>Memory Space (number of samples)</th></tr></thead><tbody><tr><td>C and T</td><td>410,000</td></tr><tr><td>C, T, and P</td><td>290,000</td></tr><tr><td>C, T, and time</td><td>225,000</td></tr><tr><td>C, T, P, and time</td><td>185,000</td></tr></tbody></table>			Recorded Parameters	Memory Space (number of samples)	C and T	410,000	C, T, and P	290,000	C, T, and time	225,000	C, T, P, and time	185,000
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C and T	410,000												
C, T, and P	290,000												
C, T, and time	225,000												
C, T, P, and time	185,000												
Real-Time Clock	Watch-crystal type 32,768 Hz; corrected for drift and aging by comparison to MicroCAT counter time-base to produce overall ± 5 ppm accuracy (±2.6 minutes/year)												
Standard Internal Batteries	Nominal 7.2 Ampere-hour pack consisting of six 9-volt lithium batteries. Capacity for more than 300,000 samples for a typical sampling scheme (see <i>Battery Endurance</i> for example calculation). See <i>Shipping Precautions</i> in <i>Section 1: Introduction</i> .												
External Input Power (optional)	0.5 Amps at 9-24 VDC. To avoid draining the internal batteries, use an external voltage greater than 10 VDC. See <i>External Power (Optional)</i> .												
Power Requirements	<div>Quiescent current: 10 microamps. Acquisition time: 1 – 3 seconds per sample (depending on sampling mode and inclusion of pressure sensor) for 1 measurement per sample (NAvg=1).</div> <div>Standard 37-SM without external power option - Communication current: 38 milliamps. Sampling current: - 20 milliamps for autonomous or serial line sync sampling. - 39 milliamps for polled sampling.</div> <div>37-SM with external power option - Communication current: 35 milliamps. Sampling current: 35 milliamps.</div>												
Housing and Depth Rating	<i>Standard:</i> Titanium housing, 7000 m (23,000 ft) <i>Optional:</i> Plastic <i>ShallowCAT</i> housing, 250 m (820 ft)												
Weight (without pressure sensor)	<i>Standard titanium housing:</i> In air: 3.8 kg (8.3 lbs) In water: 2.3 kg (5.1 lbs) <i>Optional plastic ShallowCAT housing:</i> In air: 2.7 kg (6.0 lbs) In water: 1.2 kg (2.7 lbs)												

CAUTION:

See *Section 5: Routine Maintenance and Calibration* for handling instructions for the plastic *ShallowCAT* housing.

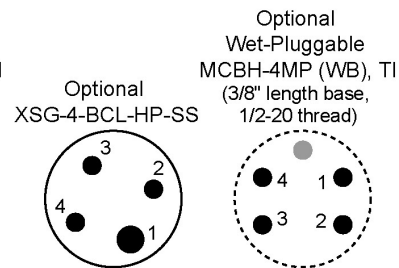
Dimensions and End Cap Connector

*Dimensions in
millimeters (inches)*



3-pin Connector

Pin	Signal
1	Common
2	RS-232 data receive
3	RS-232 data transmit



Optional 4-pin Connector

Pin	Signal
1	Common
2	RS-232 data receive
3	RS-232 data transmit
4	9-24 VDC (optional external power)

Sample Timing

Notes:

- Acquisition time shown does not include time to transmit real-time data, which is dependent on baud rate.
- If date and time are stored with the data, time is the time at the **start** of the sample, after a small amount of time for the MicroCAT to wake up and prepare to sample. For example, if the MicroCAT is programmed to wake up and sample at 12:00:00, the stored time will indicate 12:00:01 or 12:00:02.

Sample timing is dependent on several factors, including:

- Sampling mode – autonomous, polled, or serial line sync
- Inclusion of optional pressure sensor in MicroCAT
- Number of measurements taken per sample (**NAvg**)

Autonomous Sampling

Power on time for each sample while logging:

- **With pressure:** 2.83 seconds + 1.27 seconds * (**NAvg** - 1)
- **Without pressure:** 2.33 seconds + 0.87 seconds * (**NAvg** - 1)

The MicroCAT goes into quiescent (sleep) state for at least 2 seconds between each sample. If **NAvg** is large, the time required to sample plus the quiescent time may be more than the interval between samples (**Interval**); the MicroCAT will then internally set the sampling rate to **Interval** plus the actual required sampling time.

Example 1: Interval=10, NAvg=1, no pressure sensor

Sampling time = 2.33 seconds + 0.87 seconds * (**NAvg** - 1) = 2.33 + 0.87 * (1 - 1) = 2.33 seconds
 2.33 seconds + 2 seconds (for quiescent state) = 4.33 seconds < 10 second sample interval, OK.

Example 2: Interval=10, NAvg=8, no pressure sensor

Sampling time = 2.33 seconds + 0.87 seconds * (**NAvg** - 1) = 2.33 + 0.87 * (8 - 1) = 8.4 seconds
 8.4 seconds + 2 seconds (for quiescent state) = 10.4 seconds > 10 second sample interval.
 Therefore, MicroCAT internally sets sampling rate to:
 (**Interval** + actual required sampling time) = 10 seconds + 8.4 seconds = 18.4 seconds

Polled Sampling

Time from receipt of take sample command to beginning of reply:

- **With pressure:** 1.72 seconds + 1.27 seconds * (**NAvg** - 1)
- **Without pressure:** 1.22 seconds + 0.87 seconds * (**NAvg** - 1)

Minimum time (approximate) required from beginning of one sample to beginning of next sample, if **NAvg=1**:

- After **TS** command – 2 seconds
- After **TSSOn** command – 3 seconds
- After **TSS** command – 5 seconds

Serial Line Sync Sampling

Power on time for each sample:

- **With pressure:** 2.83 seconds + 1.27 seconds * (**NAvg** - 1)
- **Without pressure:** 2.33 seconds + 0.87 seconds * (**NAvg** - 1)

Battery Endurance

Notes:

- If the MicroCAT is logging data and the battery voltage is less than 6.15 volts for ten consecutive scans, the MicroCAT halts logging and displays a low battery indication in the data.
- A MicroCAT with the external power option has different power draw characteristics than the standard MicroCAT, **even when used with internal batteries**. Verify which type of MicroCAT you have before calculating battery endurance.
- See **Specifications** above for data storage limitations.

The battery pack has a nominal capacity of 7.2 amp-hours. For planning purposes, Sea-Bird recommends using a conservative value of 5 amp-hours.

Current consumption is as follows:

- Acquisition time is shown above in *Sample Timing*. Acquisition current varies, depending on the type of MicroCAT.
 - Standard MicroCAT **without external power option** - Sampling (acquisition) current is 20 milliamps for autonomous or serial line sync sampling; 39 milliamps for polled sampling.
 - MicroCAT **with external power option** - Sampling (acquisition) current is 35 milliamps.
- Quiescent current is less than 10 microamps (0.09 AH per year).

The time required for each sample is dependent on the user-programmed sampling mode, number of measurements per sample, and inclusion of a pressure sensor in the MicroCAT (see *Sample Timing* above). So, battery endurance is highly dependent on the application. Two examples follow.

Example 1: A standard MicroCAT (no external power option) with no pressure sensor is set up to sample autonomously every 10 minutes (6 samples/hour), taking 1 measurement per sample (**NAvg=1**). How long can it be deployed?

Sampling time = 2.33 seconds + 0.87 seconds * (**NAvg** - 1) = 2.33 + 0.87 * (1 - 1) = 2.33 seconds

Sampling current consumption = 0.020 amps * 2.33 seconds = 0.047 amp-seconds/sample

In 1 hour, sampling current consumption = 6 * 0.047 amp-seconds/sample = 0.28 amp-seconds/hour

Quiescent current ≈ 10 microamps = 0.01 mA

In 1 hour, quiescent current consumption = 0.01 mA * 3600 seconds/hour = 0.036 amp-seconds/hour

Total current consumption / hour = 0.28 + 0.036 = 0.32 amp-seconds/hour

Capacity = (5 amp-hours * 3600 seconds/hr) / (0.32 amp-seconds/hour) = 56250 hours = 2343 days = 6.4 years

However, Sea-Bird recommends that batteries should not be expected to last longer than 2 years in the field.

Number of samples = 56250 hours * 6 samples/hour = 337,000 samples

Example 2: Same as above, but taking 20 measurements per sample (**NAvg=20**). How long can it be deployed?

Sampling time = 2.33 seconds + 0.87 seconds * (**NAvg** - 1) = 2.33 + 0.87 * (20 - 1) = 18.86 seconds

Sampling current consumption = 0.02 amps * 18.86 seconds = 0.38 amp-seconds/sample

In 1 hour, sampling current consumption = 6 * 0.38 amp-seconds/sample = 2.28 amp-seconds/hour

Quiescent current = 10 microamps = 0.01 mA

In 1 hour, quiescent current consumption ≈ 0.01 mA * 3600 seconds/hour = 0.036 amp-seconds/hour

Total current consumption / hour = 2.28 + 0.036 = 2.32 amp-seconds/hour

Capacity = (5 amp-hours * 3600 seconds/hr) / (2.32 amp-seconds/hour) = 7758 hours = 323 days = 0.9 years

Number of samples = 7758 hours * 6 samples/hour = 46,500 samples

External Power (optional)

The MicroCAT can be ordered with an optional ability to be powered from an external source, which supplies 5 Amps at 9 – 24 VDC. The internal lithium pack is diode-OR'd with the external source, so power is drawn from whichever voltage source is higher. The MicroCAT can also be operated from the external supply without having the lithium batteries installed. Electrical isolation of conductivity is retained in units with the external power option, preventing ground loop noise contamination in the conductivity measurement.

Note:

See *Real-Time Data Acquisition* in *Section 4: Deploying and Operating MicroCAT* for baud rate limitations on cable length if transmitting real-time data.

Cable Length and Optional External Power

There are two issues to consider if powering the MicroCAT externally:

- Limiting the communication IR loss to 1 volt **if transmitting real-time data**; higher IR loss will prevent the instrument from transmitting real-time data because of the difference in ground potential.
- Supplying enough power at the power source so that sufficient power is available at the instrument after considering IR loss.

Each issue is discussed below.

Limiting Communication IR Loss to 1 Volt if Transmitting Real-Time Data

The limit to cable length is typically reached when the maximum **communication** current times the power common wire resistance is more than 1 volt, because the difference in ground potential of the MicroCAT and ground controller prevents the MicroCAT from transmitting real-time data.

$$V_{\text{limit}} = 1 \text{ volt} = IR_{\text{limit}}$$

$$\text{Maximum cable length} = R_{\text{limit}} / \text{wire resistance per foot}$$

where I = communication current required by MicroCAT (35 milliamps for MicroCAT with external power option; see *Specifications*).

Note:

Common wire resistances:

Gauge	Resistance (ohms/foot)
12	0.0016
14	0.0025
16	0.0040
18	0.0064
19	0.0081
20	0.0107
22	0.0162
24	0.0257
26	0.0410
28	0.0653

Example 1 – For 20 gauge wire, what is maximum distance to transmit power to MicroCAT if transmitting real-time data?

For 35 milliamp communications current, $R_{\text{limit}} = V_{\text{limit}} / I = 1 \text{ volt} / 0.035 \text{ Amps} = 28.5 \text{ ohms}$

For 20 gauge wire, resistance is 0.0107 ohms/foot.

Maximum cable length = $28.5 \text{ ohms} / 0.0107 \text{ ohms/foot} = 2670 \text{ feet} = 814 \text{ meters}$

Example 2 – Same as above, but there are 4 MicroCATs powered from the same power supply.

For 35 milliamp communications current, $R_{\text{limit}} = V_{\text{limit}} / I = 1 \text{ volt} / (0.035 \text{ Amps} * 4 \text{ MicroCATs}) = 7.1 \text{ ohms}$

Maximum cable length = $7.1 \text{ ohms} / 0.0107 \text{ ohms/foot} = 667 \text{ feet} = 203 \text{ meters}$ (to MicroCAT *furthest* from power source).

Supplying Enough Power to MicroCAT

Another consideration in determining maximum cable length is supplying enough power at the power source so that sufficient voltage is available, after IR loss in the cable (**from the 0.5 Amp turn-on transient, two-way resistance**), to power the MicroCAT. The power requirement varies, depending on whether any power is drawn from the batteries:

- Provide at least 10 volts, after IR loss, to prevent the MicroCAT from drawing **any** power from the batteries (if you do not want to draw down the batteries): $V - IR \geq 10 \text{ volts}$
- Provide at least 7 volts, after IR loss, if allowing the MicroCAT to draw down the batteries or if no batteries are installed: $V - IR \geq 7 \text{ volts}$

where I = MicroCAT turn-on transient (0.5 Amps; see *Specifications*).

Example 1 – For 20 gauge wire, what is maximum distance to transmit power to MicroCAT if using 12 volt power source and deploying MicroCAT with no batteries?

$$V - IR \geq 7 \text{ volts} \quad 12 \text{ volts} - (0.50 \text{ Amps}) * (0.0107 \text{ ohms/foot} * 2 * \text{cable length}) \geq 7 \text{ volts}$$

$$5 \text{ volts} \geq (0.50 \text{ Amps}) * (0.0107 \text{ ohms/foot} * 2 * \text{cable length}) \quad \text{Cable length} \leq 467 \text{ ft} = 142 \text{ meters}$$

Note that 142 meters < 814 meters (maximum distance if MicroCAT is transmitting real-time data), so IR drop in power is controlling factor for this example. Using a higher voltage power supply or a different wire gauge would increase allowable cable length.

Example 2 – Same as above, but there are 4 MicroCATs powered from same power supply.

$$V - IR \geq 7 \text{ volts} \quad 12 \text{ volts} - (0.50 \text{ Amps} * 4 \text{ MicroCATs}) * (0.0107 \text{ ohms/foot} * 2 * \text{cable length}) \geq 7 \text{ volts}$$

$$5 \text{ volts} \geq (0.50 \text{ Amps} * 4 \text{ MicroCATs}) * (0.0107 \text{ ohms/foot} * 2 * \text{cable length})$$

Cable length $\leq 116 \text{ ft} = 35 \text{ meters}$ (to MicroCAT *furthest* from power source)

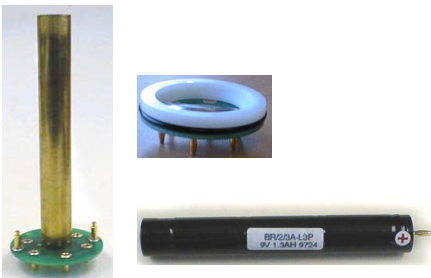
Section 3: Preparing MicroCAT for Deployment

This section describes the pre-check procedure for preparing the MicroCAT for deployment. Installation of the battery pack, installation of Sea-Bird software, and testing power and communications are discussed.

Battery Installation

WARNING!

Do not air-ship the MicroCAT with batteries installed. See *Shipping Precautions* in *Section 1: Introduction*.



Description of Batteries and Battery Pack

Sea-Bird supplies six 9-volt batteries, shipped with the MicroCAT in a separate bag.

In addition to the six 9-volt batteries, the assembled battery pack consists of:

- a brass sleeve with lower printed circuit board (PCB) containing banana jacks
- upper PCB containing banana plugs

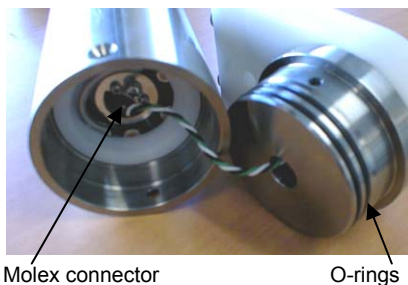
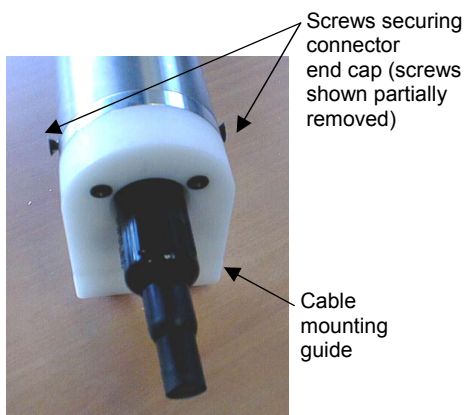
No soldering is required when assembling the battery pack because the batteries use the banana plugs and jacks as (+) and (-) terminals.

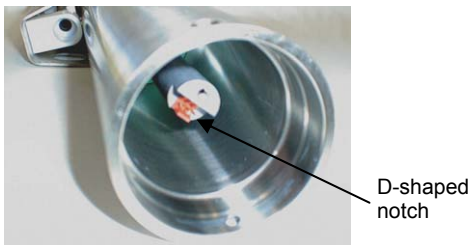
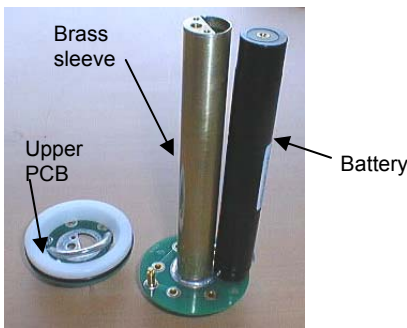
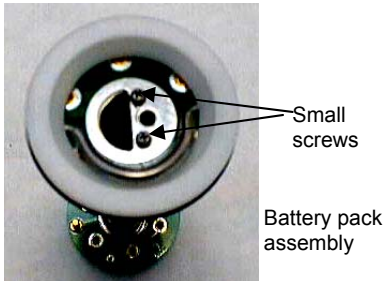
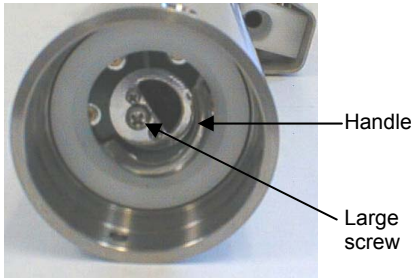
CAUTION:

See *Section 5: Routine Maintenance and Calibration* for handling instructions for the plastic *ShallowCAT* housing.

Installing Batteries

1. Remove the I/O connector end cap:
 - A. Wipe the outside of the I/O end cap and housing dry, being careful to remove any water at the seam between them.
 - B. Remove the two flat Phillips-head titanium machine screws. Do not remove any other screws from the housing.
 - C. Remove the I/O end cap by pulling firmly and steadily on the plastic cable mounting guide. It may be necessary to twist or rock the end cap back and forth or use a non-marring tool on the edge of the cap to loosen it.
 - D. The end cap is electrically connected to the electronics with a Molex connector. Holding the wire cluster near the connector, pull gently to detach the female end of the connector from the pins.
 - E. Remove any water from the O-ring mating surfaces inside the housing with a lint-free cloth or tissue.
 - F. Put the end cap aside, being careful to protect the O-rings from damage or contamination.





2. Remove the battery pack assembly from the housing:
 - A. Remove the large Phillips-head screw and lock washer from the upper PCB.
 - B. Lift the battery pack assembly straight out of the housing, using the handle.
3. Remove the two small Phillips-head screws and lock washers from the upper PCB, and lift the upper PCB off the brass sleeve.
4. Insert each 9-volt battery onto the lower PCB, one at a time, banana plug end (+) first. Ensure each battery is fully inserted.
5. Reinstall the upper PCB:
 - A. Press the upper PCB onto the battery pack assembly, aligning the screw holes and mating banana plugs to the batteries. Ensure the banana plugs are fully inserted into the batteries.
 - B. Re-fasten the upper PCB to the battery pack assembly with the two small screws and lock washers.
6. Replace the battery pack assembly in the housing:
 - A. Align the D-shaped opening in the upper PCB with the D-shaped notch on the shaft. Lower the assembly slowly into the housing, and once aligned, push gently to mate the banana plugs on the battery compartment bulkhead with the lower PCB. A post at the bottom of the battery compartment mates with a hole in the battery pack's lower PCB to prevent improper alignment.
 - B. Secure the assembly to the shaft using the large Phillips-head screw and lock washer. Ensure the screw is tight to provide a reliable electrical contact.
7. Reinstall the I/O connector end cap:
 - A. Remove any water from the O-rings and mating surfaces in the housing with a lint-free cloth or tissue. Inspect the O-rings and mating surfaces for dirt, nicks, and cuts. Clean as necessary. Apply a light coat of O-ring lubricant (Parker Super O Lube) to the O-rings and mating surfaces.
 - B. Plug the female end of the Molex connector onto the pins, with the flat portion of the female end against the flat portion of the 'D' cutout. Verify the connector is properly aligned – a backward connection will prevent communication with the computer.
 - C. Carefully fit the end cap into the housing until the O-rings are fully seated.
 - D. Reinstall the flat Phillips-head titanium screws to secure the end cap.

Software Installation

Recommended minimum system requirements for software:
Windows 2000 or later, 500 MHz processor, 256 MB RAM, and 90 MB free disk space for installation.

Note:

It is possible to use the MicroCAT without SEATERM by sending direct commands from a dumb terminal or terminal emulator, such as Windows HyperTerminal.

If not already installed, install SEATERM and other Sea-Bird software programs on your computer using the supplied software CD: :

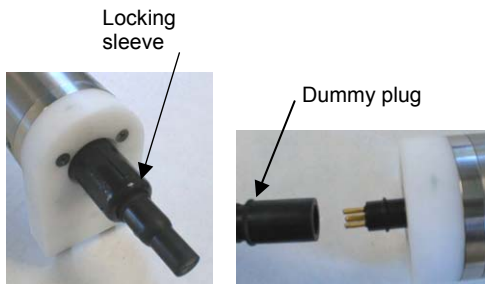
1. Insert the CD in your CD drive.
2. Double click on **Seasoft-Win32.exe**.
3. Follow the dialog box directions to install the software.

The default location for the software is c:/Program Files/Sea-Bird. Within that folder is a sub-directory for each program. The installation program allows you to install the desired components. Install all the components, or just install SEATERM (terminal program) and SBE Data Processing.

Power and Communications Test

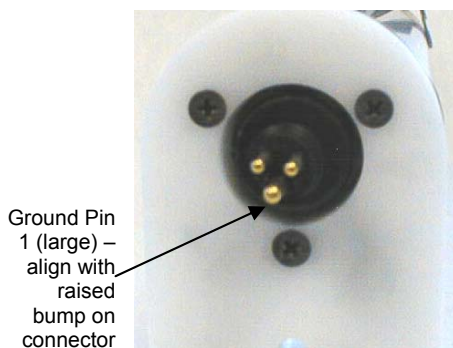
The power and communications test will verify that the system works, prior to deployment.

Test Setup



1. Remove dummy plug (if applicable):
 - A. By hand, unscrew the locking sleeve from the MicroCAT's bulkhead connector. If you must use a wrench or pliers, be careful not to loosen the bulkhead connector instead of the locking sleeve.
 - B. Remove the dummy plug from the MicroCAT's I/O bulkhead connector by pulling the plug firmly away from the connector.

Standard MicroCAT



2. **Standard Connector** - Install the I/O cable connector, aligning the raised bump on the side of the connector with the large pin (pin 1 - ground) on the MicroCAT. **OR**
MCBH Connector - Install the I/O cable connector, aligning the pins.

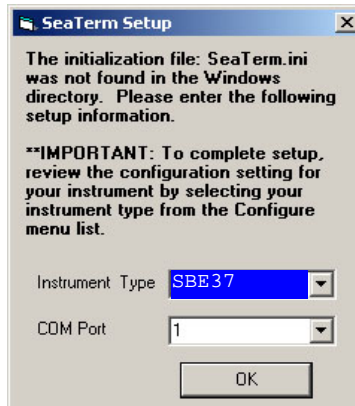
3. Connect the I/O cable to your computer's serial port.

Note:

See SEATERM's help files.

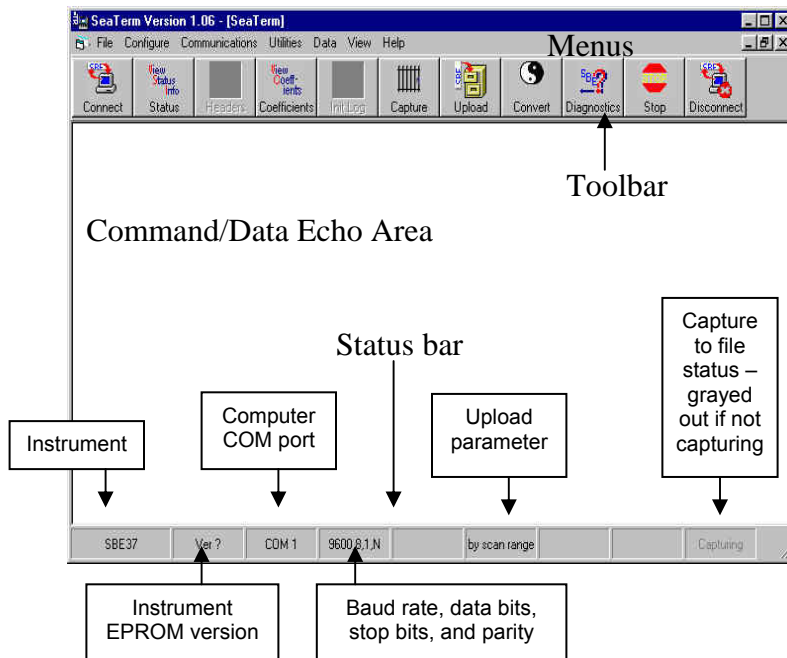
Test

1. Double click on SeaTerm.exe. If this is the first time the program is used, the setup dialog box may appear:



Select the instrument type (SBE 37) and the computer COM port for communication with the MicroCAT. Click OK.

2. The main screen looks like this:

**Note:**

There is at least one way, and as many as three ways, to enter a command:

- Manually type a command in Command/Data Echo Area.
- Use a menu to automatically generate a command.
- Use a Toolbar button to automatically generate a command.

Note:

Once the system is configured and connected (Steps 3 through 5 below), to update the Status bar:

- on the Toolbar, click Status; or
- from the Utilities menu, select Instrument Status.

SEATERM sends the status command, which displays in the Command/Data Echo Area, and updates the Status bar.

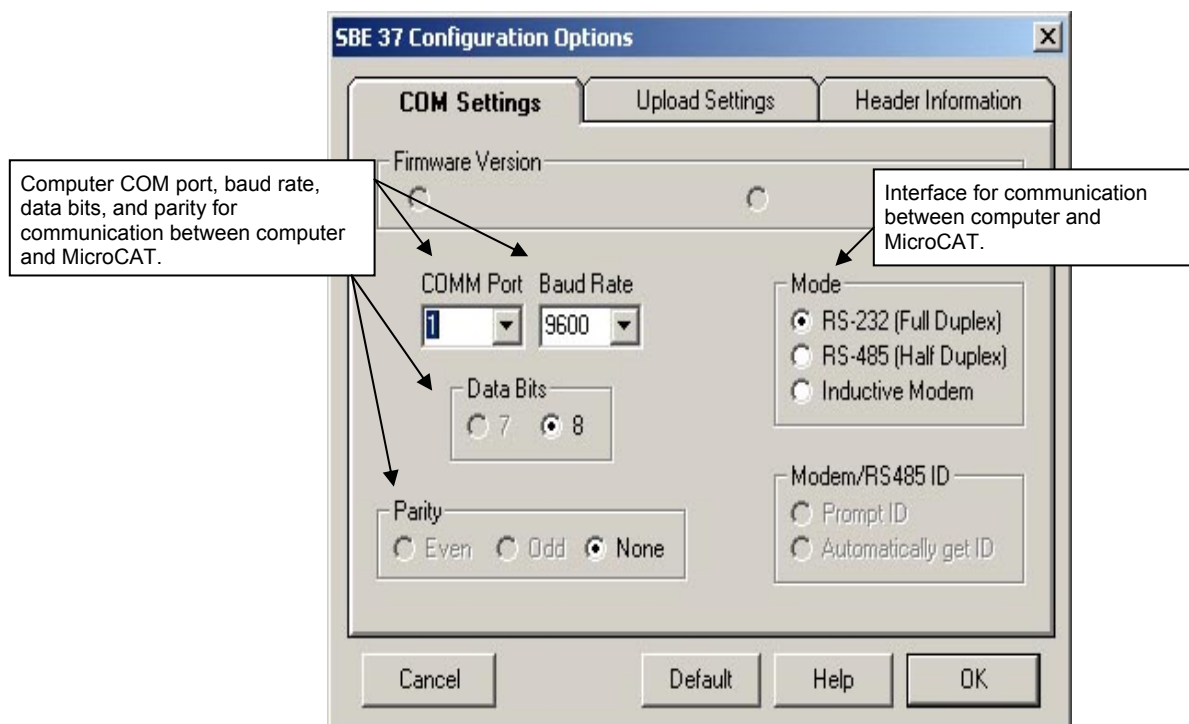
- Menus – Contains tasks and frequently executed instrument commands.
- Toolbar – Contains buttons for frequently executed tasks and instrument commands. All tasks and commands accessed through the Toolbar are also available in the Menus. To display or hide the Toolbar, select View Toolbar in the View menu. Grayed out Toolbar buttons are not applicable.
- Command/Data Echo Area – Echoes a command executed using a Menu or Toolbar button, as well as the instrument's response. Additionally, a command can be manually typed in this area, from the available commands for the instrument. Note that the instrument must be *awake* for it to respond to a command (use Connect on the Toolbar to wake up the instrument).
- Status bar – Provides status information. To display or hide the Status bar, select View Status bar in the View menu.

Following are the Toolbar buttons applicable to the MicroCAT:

Toolbar Buttons	Description	Equivalent Command*
Connect	Re-establish communications with MicroCAT. Computer responds with S> prompt. MicroCAT <i>goes to sleep</i> after 2 minutes without communication from computer have elapsed.	(press Enter key)
Status	Display instrument setup and status (logging, number of samples in memory, etc.).	DS
Coefficients	Display calibration coefficients.	DC
Capture	Capture instrument responses on screen to file; may be useful for diagnostics. File has .cap extension. Press Capture again to turn off capture. Capture status displays in Status bar.	—
Upload	Upload data stored in memory, in format Convert utility can use to allow for post-processing by SBE Data Processing. Uploaded data has .asc extension. Before using Upload: <ul style="list-style-type: none"> • Configure upload and header parameters in Configure menu. • Send Stop to stop logging. 	DDb,e (use Upload key if you will be processing data with SBE Data Processing)
Convert	Convert uploaded .asc data file to .cnv data file, which can be processed by SBE Data Processing.	—
Diagnostics	Perform one or more diagnostic tests on MicroCAT. Diagnostic test(s) accessed in this manner are non-destructive – they do not write over any existing instrument settings.	DS, DC, TS, and TSR
Stop	Interrupt and end current activity, such as uploading or diagnostic test.	—
Disconnect	Free computer COM port used to communicate with MicroCAT. COM port can then be used by another program.	—

*See *Command Descriptions* in Section 4: Deploying and Operating MicroCAT.

3. In the Configure menu, select SBE 37. The dialog box looks like this:



Notes:

- SEATERM's baud rate must be the same as the MicroCAT baud rate (set with **Baud=**). Baud is factory-set to 9600, but can be changed by the user (see *Command Descriptions* in *Section 4: Deploying and Operating MicroCAT*).
- When you click OK, SEATERM saves the Configuration Options settings to the SeaTerm.ini file in your Windows directory. SeaTerm.ini contains the last saved settings for each instrument (SBE 37, 39, etc.). When you open SEATERM and select the desired instrument in the Configure menu, the Configuration Options dialog box shows the last saved settings for that instrument.

Make the selections in the Configuration Options dialog box:

- **COMM Port:** COM 1 through COM 10, as applicable
- **Baud Rate:** 9600 (documented on Configuration Sheet in manual)
- **Data Bits:** 8
- **Parity:** None
- **Mode:** RS-232 (Full Duplex)

Click OK to save the settings.

4. In the Communications menu, select *Options / Cycle baud when connecting*.
5. Click Connect on the Toolbar. SEATERM tries to connect to the MicroCAT at the baud set in Step 3. If it cannot, it cycles through all other possible baud rates to try to connect. When it connects, the display looks like this:

```
. . . Communication Established
S>
```

This shows that correct communications between the computer and the MicroCAT has been established.

If the system does not respond with the S> prompt:

- Click Connect again or press the Enter key twice.
- Verify the correct instrument was selected in the Configure menu and the settings were entered correctly in the Configuration Options dialog box. Note that the baud rate is documented on the Configuration Sheet in this manual.
- Check cabling between the computer and MicroCAT.

Note:

The MicroCAT has a 2 minute timeout algorithm designed to:

- restore control to the computer if an illegal command is sent
- conserve battery energy if too much time elapses between commands

If the system does not appear to respond, click Connect on the Toolbar to reestablish communications.

6. Display MicroCAT status information by clicking Status on the Toolbar. The display looks like this:

```
SBE37-SM V 2.6  SERIAL NO. 2165  20 Nov 2004  08:49:08
logging not started
sample interval = 30 seconds
samplenum = 52, free = 190598
do not transmit real-time data
do not output salinity with each sample
do not output sound velocity with each sample
store time with each sample
number of samples to average = 1
serial sync mode disabled
wait time after serial sync sampling = 120 seconds
internal pump not installed
temperature = 7.54 deg C
```

7. Command the MicroCAT to take a sample by typing **TS** and pressing the Enter key. The display looks like this (if optional pressure sensor installed, **Format=1**, and not outputting salinity or sound velocity):

```
23.7658,0.00019, 0.062, 20 Nov 2004, 08:49:10
```

where 23.7658 = temperature in degrees Celsius
 0.00019 = conductivity in S/m
 0.062 = pressure in decibars
 20 Nov 2004 = date
 08:49:10 = time

These numbers should be reasonable; i.e., room temperature, zero conductivity, barometric pressure (gauge pressure), current date and time (shipped from the factory set to Pacific Daylight or Standard Time).

8. Command the MicroCAT to go to sleep (quiescent state) by typing **QS** and pressing the Enter key.

The MicroCAT is ready for programming and deployment.

Section 4:

Deploying and Operating MicroCAT

This section includes:

- system operation with example sets of operation commands
- baud rate and cable length considerations
- detailed command descriptions
- data output formats
- deploying and recovering the MicroCAT
- uploading and processing data from the MicroCAT's memory

Sampling Modes

The MicroCAT has three basic sampling modes for obtaining data:

- Polled Sampling – On command, the MicroCAT takes one sample.
- Autonomous Sampling – At pre-programmed intervals, the MicroCAT wakes up, samples, stores data in memory, and goes to sleep.
- Serial Line Synchronization – In response to a pulse on the serial line, the MicroCAT wakes up, samples, stores data in memory, and goes to sleep.

Commands can be used in various combinations to provide a high degree of operating flexibility.

Descriptions and examples of the sampling modes follow. Note that the MicroCAT's response to each command is not shown in the examples. Review the operation of the basic sampling modes and the commands described in *Command Descriptions* before setting up your system.

Polled Sampling

On command, the MicroCAT takes **NAvg** measurements, averages the measurements, and sends the averaged data to the computer. Storing of data in the MicroCAT's FLASH memory is dependent on the particular command used.

Example: Polled Sampling (user input in bold)

Wake up MicroCAT. Set the number of measurements per sample to 1. Command MicroCAT to take a sample, and send converted data to computer (do not store data in MicroCAT's memory). Send power-off command.

(Click Connect on Toolbar to wake up.)

S>**NAVG=1**

S>**TS**

S>**QS**

Note:

If the FLASH memory is filled to capacity, sampling continues, but excess data is not saved in memory (i.e., the MicroCAT does not overwrite the data in memory).

Note:

Use **Stop** to:

- stop logging
- stop waiting to start logging (after **StartLater** has been sent)

Once **Stop** is sent, the MicroCAT will accept all commands again.

Autonomous Sampling (Logging commands)

At pre-programmed intervals (**Interval**) the MicroCAT wakes up, samples data (taking **NAvg** measurements for each sample and averaging the measurements), stores the averaged data in its FLASH memory, and goes to sleep (enters quiescent state). Logging is started with **StartNow** or **StartLater**, and is stopped with **Stop**. Transmission of real-time averaged data to the computer is dependent on **TxRealTime**.

The MicroCAT has a *lockout* feature to prevent unintended interference with sampling. If the MicroCAT is logging or waiting to start logging (**StartLater** has been sent, but logging has not started yet), the MicroCAT will only accept the following commands: **DS**, **DC**, **TS**, **TSR**, **SL**, **SLT**, **SLTR**, **QS**, and **Stop**.

Additionally, if the MicroCAT is logging, **it cannot be interrupted during measurements** to accept any commands. If the MicroCAT is logging and appears unresponsive, it may be in the middle of taking measurements; continue to try to establish communications. Note that if **NAvg** is large in comparison to **Interval**, there will only be a very short period of time between samples when the MicroCAT can be interrupted; this may make it difficult to interrupt or stop sampling.

Example: Autonomous Sampling (user input in bold).

Wake up MicroCAT. Set sample number to 0 to overwrite previous data in memory. Set up to sample every 60 seconds, with 1 measurement averaged per sample. Store time and date with samples, and do not transmit real-time data to computer. Set up to automatically start logging on 10 January 2005 at 12:00:00. Send power-off command after all parameters are entered – system will automatically wake up and go to sleep for each sample.

(Click Connect on Toolbar to wake up.)

```
S>SAMPLENUM=0
S>INTERVAL=60
S>NAVG=1
S>STORETIME=Y
S>TXREALTIME=N
S>STARTMMDDYY=011005
S>STARTHHMMSS=120000
S>STARTLATER
S>DS          (to verify setup)
S>QS
```

After logging begins, look at data from last sample to check results, and then go to sleep:

(Click Connect on Toolbar to wake up.)

```
S>SL
S>QS
```

When ready to upload all data to computer, wake up MicroCAT, stop sampling, upload data, and then go to sleep:

(Click Connect on Toolbar to wake up.)

```
S>STOP
```

(Click Upload on Toolbar – program leads you through screens to define data to be uploaded and where to store it.)

```
S>QS
```

Serial Line Synchronization (Serial Line Sync)

Serial Line Sync allows a simple pulse on the RS-232 line to initiate a sample. This mode provides easy integration with ADCPs or current meters, which can synchronize MicroCAT sampling with their own without drawing on their battery or memory resources.

Note:

Use **DS** to view Serial Line Sync enable/disable status.

If this mode is enabled (**SyncMode=Y**) and the MicroCAT is powered down, setting the RS-232 RX line high (space state, 3 –10 VDC) for 1 to 1000 milliseconds initiates the following sampling sequence:

- Wake up
- Take sample (consisting of **NAvg** measurements)
- Store averaged data in FLASH memory
- Output real-time converted averaged data

After executing the above sequence, the MicroCAT checks the RS-232 line and **SyncWait**. These determine whether to power down immediately or accept commands from the computer, and whether to leave the serial line sync mode enabled or disable it:

- **SyncWait=0** and **Mark State** (RS-232 RX line less than 0.5 volts) - MicroCAT immediately goes to sleep. Serial line sync mode remains enabled (**SyncMode=Y**).
- **SyncWait=0** and **Space State** (RS-232 RX line greater than 3 volts) - MicroCAT monitors the RS-232 line for a time equivalent to 25 characters (actual length of time is dependent on the baud rate):
 - Line remains in space state - MicroCAT disables serial line sync mode (sets **SyncMode=N**) at end of time. Once serial line sync mode is disabled, place the MicroCAT in mark state; you can then communicate with the MicroCAT using the full range of commands (polled sampling, logging, upload, etc.).
 - Line returns to mark state - MicroCAT immediately goes to sleep. Serial line sync mode remains enabled (**SyncMode=Y**).
- **SyncWait>0**
MicroCAT monitors the RS-232 line for **SyncWait** seconds. During this time, place the MicroCAT in mark state. Each time a carriage return (Enter key) is detected, the time-out clock is reset to 2 minutes. Within that time period, you can communicate with the MicroCAT using the full range of commands (polled sampling, logging, upload, etc.). While the MicroCAT is monitoring:
 - If more than 25 break characters are received - MicroCAT disables serial line sync mode (sets **SyncMode=N**). Once serial line sync mode is disabled, you can communicate with the MicroCAT using the full range of commands (polled sampling, logging, upload, etc.).
 - If less than 25 break characters are received - MicroCAT goes to sleep when the time-out clock runs down. Serial line sync mode remains enabled (**SyncMode=Y**).

In summary, to disable serial line sync mode *after* executing the sampling sequence:

- If **SyncWait=0**
Put RS-232 line in space state (greater than 3 volts) for time equivalent to 25 characters.
- If **SyncWait>0**
 - Put RS-232 line in space state (greater than 3 volts) for time equivalent to 25 characters, or
 - If **SyncWait** is greater than 5 seconds, put the MicroCAT in mark state within 3 seconds of executing the sampling sequence, then send **SyncMode=N** after waiting at least 3 seconds after executing the sampling sequence.

Note:

If running **SEATERM**, select *Send 5 second break* in the Communications menu to hold the RS-232 RX line in space state for 5 seconds. This will always be more than 25 break characters, and will cause the MicroCAT to exit serial line sync mode.

*Example: **Serial Line Sync*** (user input in bold)

Wake up MicroCAT. Set sample number to 0 to overwrite previous data in memory. Set **NAvg=1** to take 1 measurement per sample. Set **SyncWait** to 0 seconds and enable serial line sync mode. Send power off command.

(Click Connect on Toolbar to wake up.)

S>**SAMPLENUM=0**

S>**NAVG=1**

S>**SYNCWAIT=25**

S>**SYNCMODE=Y**

S>**DS** (to verify setup)

S>**QS**

When ready to take a sample (repeat as desired):

(Set RS-232 RX line high [3-10 VDC] for 1-1000 milliseconds [space state]. MicroCAT takes 4 measurements, stores averaged data in memory, and outputs converted averaged data. Set RS-232 RX line low [<0.5 VDC] [mark state] – MicroCAT goes to sleep.)

(Repeat this process at periodic intervals as desired.)

When ready to upload all data to computer, disable serial line sync mode, and then upload data and go to sleep:

(Set RS-232 RX line high [3-10 VDC] for 5 seconds [space state].

MicroCAT disables serial line sync mode (sets **SyncMode=N**.)

(Set RS-232 RX line low [<0.5 VDC] [mark state].)

(Press Enter key to get S> prompt.)

S>**DS** (to verify MicroCAT is communicating)

(Click Upload on Toolbar – program leads you through screens to define data to be uploaded and where to store it.)

S>**QS**

Real-Time Data Acquisition

Notes:

- Baud rate is set with **Baud=**. Set **TxRealTime=Y** to output real-time data. See *Command Descriptions* in this section for command details.
- If using external power, see *External Power (optional)* in *Section 2: Description of MicroCAT* for power limitations on cable length.

The length of cable that the MicroCAT can drive is dependent on the baud rate. The allowable combinations are:

Maximum Cable Length (meters)	Maximum Baud Rate
1600	600
800	1200
400	2400
200	4800
100	9600
50	19200
25	38400

If acquiring real-time data, click Capture on SEATERM's Toolbar before you begin logging. The data displayed in SEATERM will be saved to the designated file. Process the data as desired. Note that this real-time data file **cannot be processed by SBE Data Processing, as it does not have the required headers and format**. To process data with SBE Data Processing, upload the data from the MicroCAT's memory.

Timeout Description

The MicroCAT has a timeout algorithm. If the MicroCAT does not receive a command for two minutes, it powers down its communication circuits to prevent exhaustion of the batteries. **To re-establish control (wake up), click Connect on the Toolbar or press the Enter key.** The system responds with the S> prompt.

Command Descriptions

This section describes commands and provides sample outputs.
See *Appendix III: Command Summary* for a summarized command list.

When entering commands:

- Input commands to the MicroCAT in upper or lower case letters and register commands by pressing the Enter key.
- The MicroCAT sends ? CMD if an invalid command is entered.
- If the system does not return an S> prompt after executing a command, press the Enter key to get the S> prompt.
- If a new command is not received within two minutes after the completion of a command, the MicroCAT returns to the quiescent (sleep) state.
- If in quiescent state, re-establish communications by clicking Connect on the Toolbar or pressing the Enter key to get an S> prompt.

Status Command**Note:**

If the battery voltage is below 6.15 volts, the following displays in response to **DS**:

WARNING: LOW BATTERY
VOLTAGE!! Replace the
batteries before continuing.

DS

Display operating status and setup.

Equivalent to Status on Toolbar.

List below includes, where applicable, command used to modify parameter.

- firmware version, serial number, date and time [MMDDYY= or DDMMYY=, and HHMMSS=]
- logging status
- sample interval time [Interval=]
- number of samples in memory [SampleNum=] and available sample space in memory
- data acquired with autonomous sampling to be transmitted real-time [TxRealTime=]?
- output salinity with each sample [OutputSal=]?
- output sound velocity with each sample [OutputSV=]?
- store date and time with each sample acquired with autonomous sampling [StoreTime=]?
- number of measurements to average for each sample [NAvg=]
- reference pressure [RefPress=]; only displays if no pressure sensor installed
- serial sync mode state [SyncMode=]
- serial sync mode wait time [SyncWait=]
- internal pump installed? (never installed in 37-SM) [PumpInstalled=N]
- current temperature

Logging status can be:

- logging not started
- logging data
- not logging: waiting to start at...
- not logging: received stop command
- not logging: low battery
- unknown status

Note:

The 37-SM and 37-SMP use the same firmware. The internal pump is applicable to the 37-SMP only.

Example: Display status for MicroCAT (user input in bold, command used to modify parameter in parentheses).

S>**DS**

SBE37-SM V 2.6 SERIAL NO. 2165 20 Nov 2004 08:49:08

[MMDDYY=, HHMMSS=]

logging data

sample interval = 30 seconds

[Interval=]

sample number = 52, free = 190598

[SampleNum=]

do not transmit real-time data

[TxRealTime=]

do not output salinity with each sample

[OutputSal=]

do not output sound velocity with each sample

[OutputSV=]

store time with each sample

[StoreTime=]

number of samples to average = 1

[NAvg=]

reference pressure = 0.0 db

[RefPress=]

serial sync mode disabled

[SyncMode=]

wait time after serial sync sampling = 120 seconds

[SyncWait=]

internal pump not installed

[PumpInstalled=N; only valid setting for 37-SM]

temperature = 7.54 deg C

Setup Commands

Notes:

- **DDMMYY=** and **MMDDYY=** are equivalent. Either can be used to set the date.
- If the battery pack has been removed, date and then time must be reset.
- **Always set date and then time.** If a new date is entered but not a new time, the new date will not be saved. If a new time is entered without first entering a new date, the date will reset to the last date it was set for with **MMDDYY=** or **DDMMYY=**.

Notes:

The MicroCAT's baud rate (set with **Baud=**) must be the same as SEATERM's baud rate (set in the Configure menu).

Notes:

- The MicroCAT does not *store* salinity and sound velocity in memory if **OutputSal=Y** and **OutputSV=Y**. It calculates and outputs the values real-time or as data is uploaded; therefore, outputting these parameters has no effect on the number of samples that can be stored in memory.
- Salinity and sound velocity can also be calculated in SBE Data Processing, from data uploaded from the MicroCAT's memory.

Notes:

- See *Data Output Formats* below.
- Date and time are included in autonomous sampling data only if **StoreTime=Y**.
- Legend:
 - t = temperature (°C, ITS-90).
 - c = conductivity (Siemens/meter).
 - p = pressure (decibars); sent only if optional pressure sensor installed.
 - s = salinity (psu); sent only if **OutputSal=Y**.
 - v = sound velocity (m/sec); sent only if **OutputSV=Y**.
 - dd mmm yyyy = day, month, year.
 - mm-dd-yyyy = month, day, year.
 - hh:mm:ss = hour, minute, second.

MMDDYY=mmddyy

Set real-time clock month, day, and year.
Must be followed by **HHMMSS=** to set time.

DDMMYY=ddmmyy

Set real-time clock day, month, and year.
Must be followed by **HHMMSS=** to set time.

HHMMSS=hhmmss

Set real-time clock hour, minute, second.

Example: Set current date and time to 10 July 2004 12:00:00
(user input in bold).

S>**MMDDYY=071004**

or

S>**DDMMYY=100704**S>**HHMMSS=120000**S>**HHMMSS=120000****Baud=x**

x= baud rate (600, 1200, 2400, 4800, 9600, 19200, or 38400). Default 9600.

Length of cable that MicroCAT can drive for real-time data is dependent on baud:

Maximum Cable Length (meters)	Maximum Baud Rate
1600	600
800	1200
400	2400
200	4800
100	9600
50	19200
25	38400

OutputSal=x

x=Y: Calculate and output salinity (psu) with each sample.

x=N: Do not.

OutputSV=x

x=Y: Calculate and output sound velocity (m/sec) with each sample, using Chen and Millero formula (UNESCO Technical Papers in Marine Science #44).

x=N: Do not.

Format=x

x=0: output raw hex data, for diagnostic use at Sea-Bird

x=1 (default): output converted data.
ttt.tttt,cc.cccccc,pppp.ppp,sss.ssss,
vvvv.vvv,dd mmm yyyy, hh:mm:ss

x=2: output converted data.
ttt.tttt,cc.cccccc,pppp.ppp,sss.ssss,
vvvv.vvv,mm-dd-yyyy, hh:mm:ss

RefPress=x

x = reference pressure (gauge) in decibars. MicroCAT without installed pressure sensor uses this reference pressure in conductivity (and optional salinity and sound velocity) calculations. Entry ignored if MicroCAT includes pressure sensor.

Setup Commands (continued)

Note:

Setting **NAvg** > 1 has a large effect on battery endurance. See *Sample Timing* and *Battery Endurance* in *Section 2: Description of MicroCAT*.

The MicroCAT's A/D converter is factory-configured to take 4 measurements of the thermistor and (optional) pressure sensor in rapid succession and record the average values; during this time the conductivity measurement is also integrated and the average is recorded. This factory setting provides the optimum trade-off between low RMS noise and battery endurance; **additional averaging with NAvG is usually unnecessary.**

NAvg=x

x= number of conductivity, temperature, and (optional) pressure measurements (1 – 1000) to take and average for each sample. Default 1; ***Sea-Bird recommends keeping NAvG=1.***

PumpInstalled=x

x=N: Internal pump is not installed (**only valid setting for 37-SM**).

x=Y: Not applicable to 37-SM.

SampleNum=x

x= sample number for first sample when sampling begins. After all previous data has been uploaded from MicroCAT, set sample number to 0 before starting to sample to make entire memory available for recording. If not reset to 0, data will be stored after last recorded sample.

Note:

Do not send SampleNum=0 until all data has been uploaded.

SampleNum=0 does not delete the data; it just resets the data pointer. **If you accidentally send this command before uploading**, recover the data as follows:

1. Set **SampleNum=x**, where **x** is your estimate of number of samples in memory.
2. Upload data. If **x** is more than actual number of samples in memory, data for non-existent samples will be bad, random data. Review uploaded data file carefully and delete any bad data.
3. If desired, increase **x** and upload data again, to see if there is additional valid data in memory.

QS

Quit session and place MicroCAT in quiescent (sleep) state. Main power is turned off. Data logging and memory retention are not affected.

Autonomous Sampling (Logging) Commands

Note:

- If the MicroCAT is logging data and the battery voltage is less than 6.15 volts for ten consecutive scans, the MicroCAT halts logging and sets the logging status to low battery.
- If the FLASH memory is filled to capacity, sampling continues, but excess data is not saved in memory (i.e., the MicroCAT does not overwrite the data in memory).

Logging commands direct the MicroCAT to sample data at pre-programmed intervals and store the data in its FLASH memory.

Interval=x

x= interval (seconds) between samples (5 - 32767). When commanded to start sampling with **StartNow** or **StartLater**, at **x** second intervals MicroCAT takes **NAvg** measurements, stores averaged data in FLASH memory, transmits real-time averaged data (if **TxRealTime=Y**), and goes to sleep.

Note:

StoreTime applies to autonomous sampling only.

StoreTime=x

x=Y: Store date and time with each sample. This adds 4 bytes per scan.

x=N: Do not.

Autonomous Sampling (Logging) Commands (*continued*)**Notes:**

- **TxRealTime** applies to autonomous sampling only.
- **TxRealTime** does not affect storing data to memory, but slightly increases current consumption and time needed to sample (and then transmit) data.
- To capture real-time data to a file, do the following *before* starting logging:
 1. Click Capture on the Toolbar.
 2. Enter the desired file name in the dialog box. The *capture* status displays in the status bar at the bottom of the screen.

TxRealTime=x

x=Y: Output real-time data. Averaged data is transmitted immediately after it is sampled. If outputting real-time data, do not set **Interval** < 10 seconds if **NAvg=1**; for larger values of **NAvg** increase **Interval** (see *Sample Timing* in *Section 2: Description of MicroCAT*).

x=N: Do not.

StartNow

Start logging now, at rate defined by **Interval**. Data is stored in FLASH memory. Data is transmitted real-time if **TxRealTime=Y**.

Notes:

- **StartDDMMYY=** and **StartMMDDYY=** are equivalent. Either can be used to set the delayed start date.
- After receiving **StartLater**, the MicroCAT displays *not logging: waiting to start* in reply to the Display Status (**DS**) command. Once logging has started, the **DS** reply displays *logging data*.
- If the delayed start date and time has already passed when **StartLater** is received, the MicroCAT executes **StartNow**.

StartMMDDYY=mmddyy

Set delayed logging start month, day, year. Must be followed by **StartHHMMSS=** to set delayed start time.

StartDDMMYY=ddmmyy

Set delayed logging start day, month, year. Must be followed by **StartHHMMSS=** to set delayed start time.

StartHHMMSS=h:mm:ss

Set delayed logging start hour, minute, second.

StartLater

Start logging at time set with delayed start date and time commands, at rate defined by **Interval**. Data is stored in FLASH memory. Data is transmitted real-time if **TxRealTime=Y**.

Example: Program MicroCAT to start logging on 20 July 2004 12:00:00 (user input in bold).

```
S>STARTMMDDYY=072004
S>STARTHHMMSS=120000
S>STARTLATER
```

or

```
S>STARTDDMMYY=200704
S>STARTHHMMSS=120000
S>STARTLATER
```

Note:

You may need to send **Stop** several times to get the MicroCAT to respond. This is most likely to occur if sampling with a small **Interval** and transmitting real-time data (**TxRealTime=Y**).

Stop

Stop logging (that was started with **StartNow** or **StartLater**) or stop waiting to start logging (if **StartLater** was sent but logging has not begun yet). Press Enter key to get S> prompt before entering **Stop**. **Stop** must be sent before uploading data using Upload on Toolbar, Upload Data in Data menu, or **DDb,e**.

Polled Sampling Commands

Note:

The MicroCAT has a buffer that stores the most recent data sample. Unlike data in the FLASH memory, data in the buffer is erased upon removal or failure of power.

On command, the MicroCAT takes **NAvg** measurements, which are averaged and stored in the buffer. To interrupt taking a sample, press the Esc key.

TS	Take sample, output converted averaged data, and leave power on. Data is not stored in FLASH memory.
TSR	Take sample, output averaged raw data, and leave power on. Data is not stored in FLASH memory.
TSS	Take sample, store averaged data in FLASH memory , output converted averaged data, and turn power off. If MicroCAT is logging or waiting to log when TSS is sent, MicroCAT executes TS instead.
TSSOn	Take sample, store averaged data in FLASH memory , output converted averaged data, and leave power on. If MicroCAT is logging or waiting to log when TSSOn is sent, MicroCAT executes TS instead.
SLT	Output converted averaged data from last sample, then take new sample, and leave power on. Data is not stored in FLASH memory.
SLTR	Output raw averaged data from last sample, then take new sample, and leave power on. Data is not stored in FLASH memory.
SL	Output converted averaged data from last sample taken with polled or autonomous sampling, and leave power on.

Serial Line Sync Commands

Note:

See *Sampling Modes* above for complete details on the operation of serial line synchronization.

SyncMode=x	<p>x=Y: Enable serial line synchronization. When RS-232 RX line is high (3-10 VDC) for 1 to 1000 milliseconds, MicroCAT takes a sample consisting of NAvg measurements, stores averaged data in FLASH memory, transmits real-time averaged data, and goes to sleep.</p> <p>x=N: Disable serial line synchronization.</p>
SyncWait=x	<p>x= time (seconds) MicroCAT monitors RS-232 line for commands after taking sample in serial line sync mode. Range 0 - 120 seconds; default 0.</p>

Notes:

- To save data to a file, click Capture on the Toolbar before entering **DDb,e**.
- See *Data Output Formats* after these *Command Descriptions*.
- **Use Upload on the Toolbar or Upload Data in the Data menu to upload data that will be processed by SBE Data Processing.** Manually entering **DDb,e** does not produce data with the required header information and required format for processing by our software. This command is included here for reference for users who are writing their own software.

Data Upload Command

Send **Stop** before uploading data.

DDb,e

Upload data from scan b to scan e.

First sample is number 1.

As data is uploaded, screen first displays start time =, sample interval =, and start sample number =.

These are start time, sample interval, and starting sample number for last set of logged data. This information can be useful in determining what data to review.

Example: Upload samples 1 through 200 for MicroCAT to a file (user input in bold).
(Click Capture on Toolbar and enter desired filename in dialog box.)
S>**DD1, 200**

Testing Commands

Data obtained with these commands is **not** stored in FLASH memory.

TT	Measure temperature 100 times or until Esc key is pressed, output converted data.
TC	Measure conductivity 100 times or until Esc key is pressed, output converted data.
TP	Measure pressure 100 times or until Esc key is pressed, output converted data.
TTR	Measure temperature 100 times or until Esc key is pressed, output raw data.
TCR	Measure conductivity 100 times or until Esc key is pressed, output raw data.
TPR	Measure pressure 100 times or until Esc key is pressed, output raw data.
TR	Measure real-time clock frequency 30 times or until Esc key is pressed, output data.

Calibration Coefficients Commands

Notes:

- Dates shown are when calibrations were performed. Calibration coefficients are initially factory-set and should agree with Calibration Certificates shipped with MicroCAT.
- See individual Coefficient Commands below for definitions of the data in the example.

DC

Display calibration coefficients.
Equivalent to Coefficients on Toolbar.

Example: Display coefficients for MicroCAT that does not have a pressure sensor (user input in bold).

```
S>DC
SBE37-SM V 2.6 2165
temperature:      19-may-03
TA0 = -9.420702e-05
TA1 =  2.937924e-04
TA2 = -3.739471e-06
TA3 =  1.909551e-07
conductivity:     19-may-03
G =               -1.036689e+00
H =               1.444342e-01
I =               -3.112137e-04
J =               3.005941e-05
CPCOR =          -9.570001e-08
CTCOR =           3.250000e-06
WBOTC =           1.968100e-05
rtc:              11-apr-03
RTCA0 =           9.999782e-01
RTCA1 =           1.749351e-06
RTCA2 =          -3.497835e-08
```

The individual Coefficient Commands listed below are used to modify a particular coefficient or date:

Note:

F = floating point number
S = string with no spaces

TCalDate=S	S=Temperature calibration date
TA0=F	F=Temperature A0
TA1=F	F=Temperature A1
TA2=F	F=Temperature A2
TA3=F	F=Temperature A3
CalDate=S	S=Conductivity calibration date
CG=F	F=Conductivity G
CH=F	F=Conductivity H
CI=F	F=Conductivity I
CJ=F	F=Conductivity J
WBOTC=F	F=Conductivity wbotc
CTCOR=F	F=Conductivity ctcor
CPCOR=F	F=Conductivity cpcor
PCalDate=S	S=Pressure calibration date
PA0=F	F=Pressure A0
PA1=F	F=Pressure A1
PA2=F	F=Pressure A2
PTCA0=F	F=Pressure ptca0
PTCA1=F	F=Pressure ptca1
PTCA2=F	F=Pressure ptca2
PTCB0=F	F=Pressure ptcb0
PTCB1=F	F=Pressure ptcb1
PTCB2=F	F=Pressure ptcb2
POffset=F	F=Pressure offset
RCalDate=S	S=Real-time clock calibration date
RTCA0=F	F=Real-time clock A0
RTCA1=F	F=Real-time clock A1
RTCA2=F	F=Real-time clock A2

Data Output Formats

Notes (for **Format=1** or **2**):

t = temperature (°C, ITS-90)

c = conductivity (S/m)

p = pressure (decibars); included only if optional pressure sensor installed

s = salinity (psu); sent only if

OutputSal=Y.

v = sound velocity (m/sec); sent only if **OutputSV=Y**.

dd mmm yyyy = day, month (Jan, Feb, Mar, etc.), year

mm-dd-yyyy = month, day, year

hh:mm:ss = hour, minute, second.

Note that time is the time at the

start of the sample.

- There is a comma but no space between temperature and conductivity. All other data is separated with a comma and space.
- Date and time are included with autonomous sampling data only if **StoreTime=Y**.
- When **TxRealTime=Y**, real-time autonomous data transmitted to the computer is preceded by a # sign and a space.
- The MicroCAT's pressure sensor is an absolute sensor, so its **raw** output includes the effect of atmospheric pressure (14.7 psi). As shown on the Calibration Sheet, Sea-Bird's calibration (and resulting calibration coefficients) is in terms of psia. However, when outputting pressure in **decibars**, the MicroCAT outputs pressure relative to the ocean surface (i.e., at the surface the output pressure is 0 decibars). The MicroCAT uses the following equation to convert psia to decibars:
pressure (db) =
[pressure (psia) - 14.7] * 0.689476

Each scan ends with a carriage return <CR> and line feed <LF>.

- **Format=0**
Raw hex data, intended only for diagnostic use at Sea-Bird.
- **Format=1** (default)
ttt.tttt,cc.cccccc, pppp.ppp, sss.ssss, vvvv.vvv, dd mmm yyyy, hh:mm:ss
Leading zeros are suppressed, except for one zero to the left of the decimal point.
- **Format=2**
ttt.tttt,cc.cccccc, pppp.ppp, sss.ssss, vvvv.vvv, mm-dd-yyyy, hh:mm:ss
Leading zeros are suppressed, except for one zero to the left of the decimal point.

Example: Sample data output when pressure sensor is installed, **StoreTime=Y**, **OutputSal=Y**, **OutputSV=Y**, and **Format=1**:

4.1960, 3.53255, 2184.494, 36.9305, 1506.185,
07 Nov 2004, 14:28:00

(temperature,conductivity, pressure, salinity, sound velocity, date, time)

Setup for Deployment

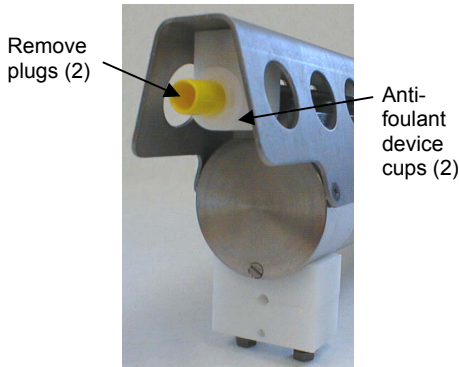
1. Install new batteries (see *Section 5: Routine Maintenance and Calibration*) or ensure the existing battery pack has enough capacity to cover the intended deployment..
2. Program the MicroCAT for the intended deployment (see *Section 3: Preparing MicroCAT for Deployment* for connection information; see information in this section on commands and sampling modes):
 - A. Ensure all data has been uploaded, and then set **SampleNum=0** to make the entire memory available for recording. If **SampleNum** is not reset to 0, data will be stored after the last recorded sample.
 - B. Set the date and then time.
 - C. Establish the setup and logging parameters.
 - D. Use **one** of the following command sequences to initiate sampling:
 - **StartNow** to start logging now, taking a sample consisting of **NAvg** measurements every **Interval** seconds.
 - **StartMMDDYY=**, **StartHHMMSS=**, and **StartLater** to start logging at the specified date and time, taking a sample consisting of **NAvg** measurements every **Interval** seconds.
 - **SyncMode=Y** to place the MicroCAT in serial line sync mode, so that a simple pulse on the RS-232 line will initiate a sample consisting of **NAvg** measurements.

Notes:

- If the battery pack has been removed, the date and time must be reset.
- **Always set date and then time.** If a new date is entered but not a new time, the new date will not be saved. If a new time is entered without first entering a new date, the date will reset to the last date it was set for with **MMDDYY=** or **DDMMYY=**.

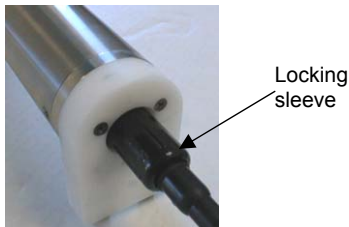
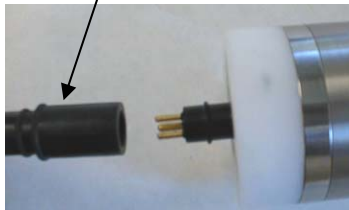
Deployment

The MicroCAT comes standard with a pre-installed Sea-Bird wire mounting clamp and guide.



CAUTION:
Do not use WD-40 or other petroleum-based lubricants, as they will damage the connectors.

Dummy plug or I/O cable connector
(as applicable)



Locking
sleeve



Standard mounting
clamp and guide –
loosen hardware to
separate clamp/guide
halves and mount on
mooring cable

1. New MicroCATs are shipped with AF24173 Anti-Foulant Devices and protective plugs pre-installed.
 - A. Remove the protective plugs, if installed, from the anti-foulant device cups. **The protective plugs must be removed prior to deployment or pressurization.** If the plugs are left in place during deployment, the sensor will not register conductivity. If left in place during pressurization, the cell may be destroyed.
 - B. Verify that the anti-foulant device cups contain AF24173 Anti-Foulant Devices (see *Section 5: Routine Maintenance and Calibration*).
2. Install the dummy plug or I/O cable (for optional external power and/or serial communication during deployment):
 - A. Lightly lubricate the inside of the dummy plug or cable connector with silicone grease (DC-4 or equivalent).
 - B. **Standard Connector** (shown in photos) - Install the dummy plug or cable connector, aligning the raised bump on the side of the plug/connector with the large pin (pin 1 - ground) on the MicroCAT. Remove any trapped air by *burping* or gently squeezing the plug/connector near the top and moving your fingers toward the end cap. **OR**
MCBH Connector – Install the plug/cable connector, aligning the pins.
 - C. Place the locking sleeve over the plug/connector. Tighten the locking sleeve finger tight only. **Do not overtighten the locking sleeve and do not use a wrench or pliers.**
3. Attach the mounting clamp and guide to the mooring cable.
4. Verify that the hardware and external fittings are secure.
5. Deploy the MicroCAT.

Recovery

WARNING!

If the MicroCAT stops working while underwater, is unresponsive to commands, or shows other signs of flooding or damage, carefully secure it away from people until you have determined that abnormal internal pressure does not exist or has been relieved. Pressure housings may flood under pressure due to dirty or damaged o-rings, or other failed seals. When a sealed pressure housing floods at great depths and is subsequently raised to the surface, water may be trapped at the pressure at which it entered the housing, presenting a danger if the housing is opened before relieving the internal pressure. Instances of such flooding are rare. However, a housing that floods at 5000 meters depth holds an internal pressure of more than 7000 psia, and has the potential to eject the end cap with lethal force. A housing that floods at 50 meters holds an internal pressure of more than 85 psia; this force could still cause injury.

If you suspect the MicroCAT is flooded, point it in a safe direction away from people, and loosen the bulkhead connector very slowly, at least 1 turn. This opens an o-ring seal under the connector. Look for signs of internal pressure (hissing or water leak). If internal pressure is detected, let it bleed off slowly past the connector o-ring. Then, you can safely remove the end cap.

Physical Handling

1. Rinse the conductivity cell with fresh water. (See *Section 5: Routine Maintenance and Calibration* for cell cleaning and storage.)
2. Reinsert the protective plugs in the anti-foulant device cups.
3. If the batteries are exhausted, new batteries must be installed before the data can be extracted. Stored data will not be lost as a result of exhaustion or removal of batteries, but the current date and time will have to be re-entered upon redeployment. (See *Section 5: Routine Maintenance and Calibration* for replacement of batteries.)
4. If immediate redeployment is not required, it is best to leave the MicroCAT with batteries in place and in a quiescent state (**QS**), so that date and time are retained. Because the quiescent current required is only 10 microamps, the batteries can be left in place without significant loss of capacity (less than 2% loss per year).

Uploading Data

Note:

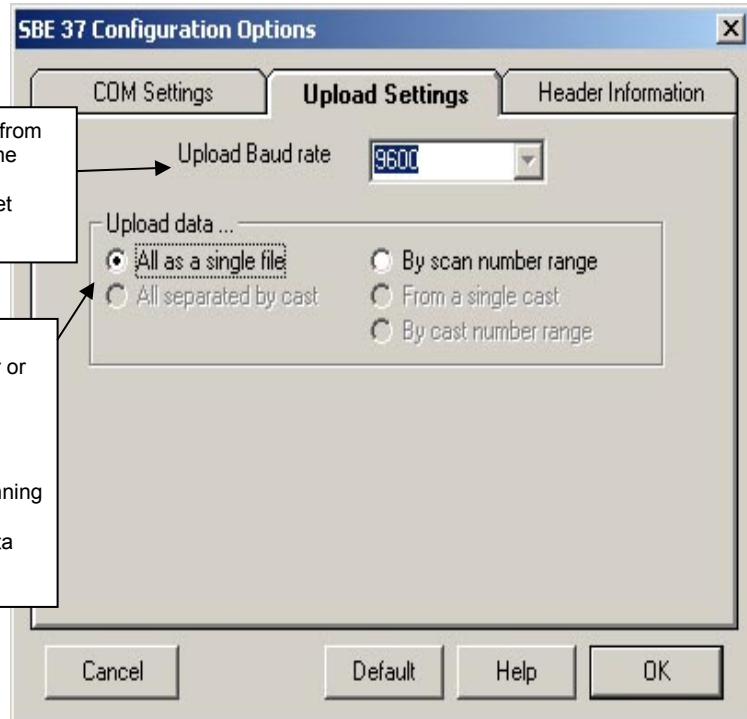
Data may be uploaded during deployment or after recovery. If uploading after recovery, connect the I/O cable as described in *Power and Communications Test* in *Section 3: Preparing MicroCAT for Deployment*.

1. Double click on SeaTerm.exe. The display shows the main screen.
2. In the Configure menu, select SBE 37. Click on the Upload Settings tab. The dialog box looks like this:

Baud rate for uploading data from MicroCAT to computer is same as baud rate for general communication, which was set on COM Settings tab.

Defines data upload type when using Upload button on Toolbar or Upload Data in Data menu:

- All as single file – All data uploaded into one file.
- By scan number range – SEATERM prompts for beginning and ending scan (sample) numbers, and uploads all data within range into one file.



Note:

Set up **Upload Settings**, **Header Information**, and/or **Header Form** (Steps 2 through 4):

- The first time you upload data, and
- If you want to change upload or header parameters.

Make the selection for Upload Settings.

3. Click on the Header Information tab. The dialog box looks like this:

Defines header information included with uploaded data:

- Prompt for header information – Each time data is uploaded, user is prompted to fill out user-defined header form.
- Include default header form in upload file – User-defined default header form included in upload file. User is not prompted to add any information when data is uploaded.
- Do not include default header form in upload file – Header information not included in upload file.



Select the desired header information option. Click OK to save the settings.

4. In the Configure menu, select Header Form to customize the header. The dialog box looks like this (default prompts are shown):

The entries are free form, 0 to 12 lines long. This dialog box establishes:

- header prompts that appear for the user to fill in when uploading data, if *Prompt for header information* was selected in the Configuration Options dialog box (Step 3)
- header included with the uploaded data, if *Include default header form in upload file* was selected in the Configuration Options dialog box (Step 3)

Enter the desired header/header prompts. Click OK.

5. Click Connect on the Toolbar to begin communications with the MicroCAT. The display looks like this:

```
. . . Communication Established
S>
```

This shows that correct communications between the computer and the MicroCAT has been established.

If the system does not respond as shown above:

- Click Connect again.
- Check cabling between the computer and MicroCAT.
- Verify the correct instrument was selected and the COM settings were entered correctly in the Configure menu.

Note:

You may need to send **Stop** several times to get the MicroCAT to respond.

6. If sampling autonomously, command the MicroCAT to stop logging by pressing the Enter key and sending **Stop**.

7. Display MicroCAT status information by clicking Status on the Toolbar. The display looks like this:

```
SBE37-SM V 2.6 SERIAL NO. 2165 20 Nov 2004 08:49:08
not logging: received stop command
sample interval = 30 seconds
samplenumber = 52, free = 190598
do not transmit real-time data
do not output salinity with each sample
do not output sound velocity with each sample
store time with each sample
number of samples to average = 1
serial sync mode disabled
wait time after serial sync sampling = 120 seconds
internal pump not installed
temperature = 7.54 deg C
```

8. Click Upload on the Toolbar to upload stored data. SEATERM responds as follows:
 - A. SEATERM sends the status command (**DS**), displays the response, and writes the command and response to the upload file. This provides you with information regarding the number of samples in memory.
 - B. **If you selected *By scan number range* in the Configuration Options dialog box (Configure menu)** – a dialog box requests the range. Enter the desired value(s), and click OK.
 - C. SEATERM sends the calibration coefficients command (**DC**), displays the response, and writes the command and response to the upload file. This displays the calibration coefficients.
 - D. **If you selected *Prompt for header information* in the Configuration Options dialog box (Configure menu)** – a dialog box with the header form appears. Enter the desired header information, and click OK.
 - E. In the Open dialog box, enter the desired upload file name and click OK. The upload file has a .asc extension.
 - F. SEATERM sends the data upload (**DDb,e**) command.
 - G. When the data has been uploaded, SEATERM shows the S> prompt.

9. Ensure all data has been uploaded from the MicroCAT by reviewing the data:

- A. SEATERM contains a utility to convert the .asc file to a .cnv file that can be used by SBE Data Processing. To convert the data:
 - 1) In SEATERM, click Convert on the Toolbar. The Convert dialog box appears.
 - 2) In the dialog box, enter the input (.asc) file name and the desired output (.cnv) file name; file names must include the path.
 - 3) If desired, click *Start new year at Julian time 0* to reset the Julian Day to 0 on January 1. Date and time (if present in the uploaded file) is converted to Julian Day with five significant digits. As the default, Convert does not reset the Julian Day to 0 when rolling over from December 31 to January 1.
 - 4) If desired, click *Insert deployment pressure*. A field for the deployment pressure appears in the dialog box; enter the pressure (in decibars) at which the MicroCAT was deployed. Convert adds a pressure column to the data; the entered deployment pressure is inserted in every row of the pressure column in the output .cnv file.

Notes:

- The entered deployment pressure can differ from the reference pressure entered prior to deployment using **RefPress=**. Pressure, used internally by the MicroCAT to calculate conductivity, has only a small effect on conductivity. However, pressure has a larger effect on the salinity calculation (performed in SBE Data Processing's Derive module). Entering the deployment pressure when converting the data allows you to provide more accurate pressure information than may have been available prior to deployment, for calculation of salinity and other parameters in SBE Data Processing.
- If your MicroCAT includes an optional pressure sensor, entering a deployment pressure has no effect on the data. Convert **does not overwrite the actual pressure data** in the file with the entered deployment pressure.

- B. Use SBE Data Processing's Derive module to compute salinity, density, and other parameters. See the software manual on CD-ROM or Help files for complete details.

Notes:

To prepare for re-deployment:

1. After all data has been uploaded, send **SampleNum=0**. If this is not sent, new data will be stored after the last recorded sample, preventing use of the entire memory capacity.
 2. Do *one* of the following:
 - Send **QS** to put the MicroCAT in quiescent (sleep) state until ready to redeploy. Leaving the MicroCAT with the batteries in place and in quiescent state retains the date and time. Quiescent current is only 10 microamps, so the batteries can be left in place without significant loss of capacity.
 - Use **StartNow** to begin logging immediately.
 - Set a date and time for logging to start using **StartMMDDYY=** or **StartDDMMYY=**, **StartHHMMSS=**, and **StartLater**.
- 1) Derive will require you to select an instrument configuration (.con) file before it processes data. A MicroCAT does not have a .con file, but you can use a .con file from **any** other Sea-Bird instrument; the contents of the .con file will not affect the results. If you do not have a .con file for another Sea-Bird instrument, create one by clicking SBE Data Processing's Configure menu and selecting **any** instrument. In the Configuration dialog box, click Save As, and save the .con file with the desired name and location; for ease of use, save the file with the same name and to the same directory as your .cnv file (for example, save the .con file for test.cnv as test.con).
 - 2) In SBE Data Processing's Run menu, select Derive.
 - 3) In the Derive dialog box, click on the File Setup tab. Select the instrument configuration (.con) file from Step 9B1. Select the .cnv file you created in Step 9A.
 - 4) Click on the Data Setup tab, and click Select Derived Variables. Select the desired output variables, and click OK. Then click Start Process. Derive will output a .cnv file which includes all the data in the input .cnv file as well as the desired derived variables.

- C. Use SBE Data Processing's SeaPlot module to plot the data.

Section 5: Routine Maintenance and Calibration

This section reviews corrosion precautions, connector mating and maintenance, conductivity cell cleaning and storage, pressure sensor maintenance, plastic housing handling instructions, replacement of batteries, replacement of AF24173 Anti-Foulant Devices, and sensor calibration. The accuracy of the MicroCAT is sustained by the care and calibration of the sensors and by establishing proper handling practices.

Corrosion Precautions

Rinse the MicroCAT with fresh water after use and prior to storage.

All exposed metal is titanium; other materials are plastic. No corrosion precautions are required, but direct electrical connection of the MicroCAT housing to mooring or other dissimilar metal hardware should be avoided.

Connector Mating and Maintenance

CAUTION:

Do not use WD-40 or other petroleum-based lubricants, as they will damage the connectors.

A mated connector does not require periodic disassembly or other attention. Inspect a connector that is unmated for signs of corrosion product around the pins. When remating:

1. Lightly lubricate the inside of the dummy plug/cable connector with silicone grease (DC-4 or equivalent).
2. **Standard Connector** - Install the plug/cable connector, aligning the raised bump on the side of the plug/cable connector with the large pin (pin 1 - ground) on the MicroCAT. Remove any trapped air by *burping* or gently squeezing the plug/connector near the top and moving your fingers toward the end cap. **OR**
MCBH Connector – Install the plug/cable connector, aligning the pins.
3. Place the locking sleeve over the plug/cable connector. Tighten the locking sleeve finger tight only. **Do not overtighten the locking sleeve and do not use a wrench or pliers.**

Verify that a cable or dummy plug is installed on the MicroCAT before deployment.

Conductivity Cell Maintenance

CAUTIONS:

- **Do not put a brush or any object inside the conductivity cell to clean it.** Touching and bending the electrodes can change the calibration. Large bends and movement of the electrodes can damage the cell.
- **Do not store the MicroCAT with water in the conductivity cell.** Freezing temperatures (for example, in Arctic environments or during air shipment) can break the conductivity cell if it is full of water.



The MicroCAT's conductivity cell is shipped dry to prevent freezing in shipping. **Refer to *Application Note 2D: Instructions for Care and Cleaning of Conductivity Cells* for conductivity cell cleaning procedures and cleaning materials.**

- The Active Use (after each cast) section of the application note is not applicable to the MicroCAT, which is intended for use as a moored instrument.

A conductivity cell filling and storage kit is available from Sea-Bird. The kit (PN 50087.1) includes a syringe and tubing assembly, and two anti-foulant device caps with hose barbs. The tubing cannot attach to an anti-foulant device cap that is not barbed.

Cleaning and storage instructions require use of the syringe and tubing assembly at the intake end of the cell (requiring one barbed cap), and looping Tygon tubing from end to end of the cell (requiring two barbed caps). Remove the installed anti-foulant device cap(s) and replace them with the anti-foulant device cap(s) with hose barbs **for cleaning and storage only**. Remember to reinstall the original anti-foulant device cap(s) before deployment. **Deploying a MicroCAT with barbed anti-foulant device cap(s) in place of the installed caps is likely to produce undesirable results in your data.** See *Replacing Anti-Foulant Devices* for safety precautions when handling the AF24173 Anti-Foulant Devices.

Pressure Sensor (optional) Maintenance



Pressure sensor port plug

The pressure port plug has a small vent hole to allow hydrostatic pressure to be transmitted to the pressure sensor inside the instrument, while providing protection for the pressure sensor, keeping most particles and debris out of the pressure port.

Periodically (approximately once a year) inspect the pressure port to remove any particles, debris, etc:

1. Unscrew the pressure port plug from the pressure port.
2. Rinse the pressure port with warm, de-ionized water to remove any particles, debris, etc.
3. Replace the pressure port plug.

CAUTION:

Do not put a brush or any object in the pressure port. Doing so may damage or break the pressure sensor.

Handling Instructions for Plastic *ShallowCAT* Option



See detail
below

Screw securing battery/connector
end cap (one each side)



Detail - Battery/connector end cap

The MicroCAT's standard 7000-meter titanium housing offers the best durability with a modest amount of care. The *ShallowCAT* option, substitution of a 250-meter plastic housing, saves money and weight. However, more care and caution in handling is required. To get the same excellent performance and longevity for the plastic-housing version:

- The MicroCAT's battery end cap is retained by two screws through the side of the housing. The screw holes are close to the end of the housing. Particularly in a cold environment, where plastic is more brittle, the potential for developing a crack around the screw hole(s) is greater for the plastic housing than for the titanium housing. Observe the following precautions –
 - When removing the end cap (to replace the batteries and/or to access the electronics), be careful to avoid any impact in this area of the housing.
 - When reinstalling the end cap, do not use excess torque on the screws. Sea-Bird recommends tightening the screws to 15 inch-lbs. Alternatively, tighten the screws finger-tight, and then turn each screw an additional 45 degrees.
- A plastic housing is more susceptible to scratches than a titanium housing. Do not use screwdrivers or other metal tools to pry off the end cap.
 - Of primary concern are scratches on O-ring mating and sealing surfaces. Take extra precaution to avoid a scraping contact with these surfaces when replacing batteries and/or re-seating the end cap.
 - Also take care to keep the O-ring lubricated surfaces clean – avoid trapping any sand or fine grit that can scratch the critical sealing surfaces. If the O-ring lubricant does accumulate any material or grit that can cause a leak or make a scratch, it must be carefully cleaned and replaced with fresh, clean lubricant (Parker Super O Lube).
 - Shallow, external scratches are cosmetic only, and will not affect the performance of the MicroCAT. However, deep external scratches can become points of weakness for deep deployments or fracture from impact during very cold weather.
- If you remove the screws securing the conductivity cell guard to the housing (not typically done by the customer), follow the same precautions as described above for removing and replacing the battery end cap.

See *Battery Installation* in *Section 3: Preparing MicroCAT for Deployment* and *Appendix II: Electronics Disassembly / Reassembly* for detailed step-by-step procedures for removing the MicroCAT's end cap.

Replacing Batteries

See Installing Batteries in Section 3: Preparing MicroCAT for Deployment.

1. Remove the I/O connector end cap and battery pack assembly.
2. Remove the upper PCB from the assembly as follows:
 - A. Remove the two small Phillips-head screws and lock washers from the upper PCB.
 - B. Carefully pry the upper PCB away from the batteries, gently going around the circle of batteries to avoid bending the banana plugs.
3. Remove the existing batteries and replace with new batteries, banana plug end (+) first. Ensure each battery is fully inserted.
4. Reinstall the upper PCB, replace the battery pack assembly, and reinstall the end cap.

Replacing Anti-Foulant Devices (SBE 37-SI, SM, IM)



AF24173
Anti-Foulant
Device

WARNING!

AF24173 Anti-Foulant Devices contain bis(tributyltin) oxide. Handle the devices only with rubber or latex gloves. Wear eye protection. Wash with soap and water after handling.

Read precautionary information on product label (see Appendix IV) before proceeding.

It is a violation of US Federal Law to use this product in a manner inconsistent with its labeling.

The MicroCAT has an anti-foulant device cup and cap on each end of the cell. New MicroCATs are shipped with an Anti-Foulant Device and a protective plug pre-installed in each cup.

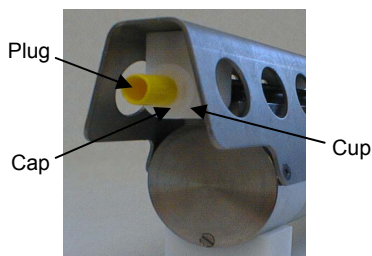
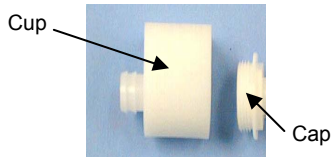
Wearing rubber or latex gloves, follow this procedure to replace each Anti-Foulant Device (two):

1. Remove the protective plug from the anti-foulant device cup;
2. Unscrew the cap with a 5/8-inch socket wrench;
3. Remove the old Anti-Foulant Device. If the old device is difficult to remove:

- Use needle-nose pliers and carefully break up material;
- If necessary, remove the guard to provide easier access.

Place the new Anti-Foulant Device in the cup;

4. Rethread the cap onto the cup. Do not over tighten;
5. If the MicroCAT is to be stored, reinstall the protective plug. **Note that the plugs must be removed prior to deployment or pressurization.** If the plugs are left in place during deployment, the cell will not register conductivity. If left in place during pressurization, the cell may be destroyed.



CAUTION:

Anti-foulant device cups are attached to the guard and connected with tubing to the cell. **Removing the guard without disconnecting the cups from the guard will break the cell.** If the guard must be removed:

1. Remove the two screws connecting each anti-foulant device cup to the guard.
2. Remove the four Phillips-head screws connecting the guard to the housing and sensor end cap.
3. Gently lift the guard away.

Sensor Calibration

Notes:

- Batteries must be removed before returning the MicroCAT to Sea-Bird. Do not return used batteries to Sea-Bird when shipping the MicroCAT for recalibration or repair.
- Please remove AF24173 Anti-Foulant Devices from the anti-foulant device cups before returning the MicroCAT to Sea-Bird. Store them for future use. See *Replacing Anti-Foulant Devices* for removal procedure.

Sea-Bird sensors are calibrated by subjecting them to known physical conditions and measuring the sensor responses. Coefficients are then computed, which may be used with appropriate algorithms to obtain engineering units. The conductivity and temperature sensors on the MicroCAT are supplied fully calibrated, with coefficients printed on their respective Calibration Certificates (see back of manual). These coefficients have been stored in the MicroCAT's EEPROM.

We recommend that MicroCATs be returned to Sea-Bird for calibration.

Conductivity Sensor Calibration

The conductivity sensor incorporates a fixed precision resistor in parallel with the cell. When the cell is dry and in air, the sensor's electrical circuitry outputs a frequency representative of the fixed resistor. This frequency is recorded on the Calibration Certificate and should remain stable (within 1 Hz) over time.

The primary mechanism for calibration drift in conductivity sensors is the fouling of the cell by chemical or biological deposits. Fouling changes the cell geometry, resulting in a shift in cell constant.

Accordingly, the most important determinant of long-term sensor accuracy is the cleanliness of the cell. We recommend that the conductivity sensor be calibrated before and after deployment, but particularly when the cell has been exposed to contamination by oil slicks or biological material.

Temperature Sensor Calibration

The primary source of temperature sensor calibration drift is the aging of the thermistor element. Sensor drift will usually be a few thousandths of a degree during the first year, and less in subsequent intervals. Sensor drift is not substantially dependent upon the environmental conditions of use, and — unlike platinum or copper elements — the thermistor is insensitive to shock.

Pressure Sensor (optional) Calibration

The optional strain-gauge pressure sensor is a mechanical diaphragm type, with an initial static error band of 0.05%. Consequently, the sensor is capable of meeting the MicroCAT's 0.10% error specification with some allowance for aging and ambient-temperature induced drift.

Pressure sensors show most of their error as a linear offset from zero.

A technique is provided below for making small corrections to the pressure sensor calibration using the *offset* (**POffset=**) calibration coefficient term by comparing MicroCAT pressure output to readings from a barometer.

Allow the MicroCAT to equilibrate in a reasonably constant temperature environment for at least 5 hours before starting. Pressure sensors exhibit a transient change in their output in response to changes in their environmental temperature. Sea-Bird instruments are constructed to minimize this by thermally decoupling the sensor from the body of the instrument. However, there is still some residual effect; allowing the MicroCAT to equilibrate before starting will provide the most accurate calibration correction.

Note:

The MicroCAT's pressure sensor is an absolute sensor, so its **raw** output (**Format=0**) includes the effect of atmospheric pressure (14.7 psi). As shown on the Calibration Sheet, Sea-Bird's calibration (and resulting calibration coefficients) is in terms of psia. However, when outputting pressure in **engineering units**, the MicroCAT outputs pressure relative to the ocean surface (i.e., at the surface the output pressure is 0 decibars). The MicroCAT uses the following equation to convert psia to decibars:
 Pressure (db) =
 $[\text{pressure (psia)} - 14.7] * 0.689476$

1. Place the MicroCAT in the orientation it will have when deployed.
2. In SEATERM:
 - A. Set the pressure offset to 0.0 (**POffset=0**).
 - B. Send **TP** to measure the MicroCAT pressure 100 times and transmit converted data (decibars).
3. Compare the MicroCAT output to the reading from a good barometer at the same elevation as the MicroCAT's pressure sensor.
 Calculate *offset* = barometer reading – MicroCAT reading
4. Enter the calculated offset (positive or negative) in the MicroCAT's EEPROM, using **POffset=** in SEATERM.

Offset Correction Example

Absolute pressure measured by a barometer is 1010.50 mbar. Pressure displayed from MicroCAT is -2.5 dbars.

Convert barometer reading to dbars using the relationship: $\text{mbar} * 0.01 = \text{dbar}$

Barometer reading = $1010.50 \text{ mbar} * 0.01 = 10.1050 \text{ dbar}$

The MicroCAT's internal calculations output gage pressure, using an assumed value of 14.7 psi for atmospheric pressure. Convert MicroCAT reading from gage to absolute by adding 14.7 psia to the MicroCAT's output:

$-2.5 \text{ dbars} + (14.7 \text{ psi} * 0.689476 \text{ dbar/psia}) = -2.5 + 10.13 = 7.635 \text{ dbars}$

Offset = $10.1050 - 7.635 = +2.47 \text{ dbars}$

Enter offset in MicroCAT.

For demanding applications, or where the sensor's air ambient pressure response has changed significantly, calibration using a dead-weight generator is recommended. The pressure sensor port uses a 7/16-20 straight thread for mechanical connection to the pressure source. Use a fitting that has an O-ring tapered seal, such as Swagelok-200-1-4ST, which conforms to MS16142 boss.

Section 6: Troubleshooting

This section reviews common problems in operating the MicroCAT, and provides the most common causes and solutions.

Problem 1: Unable to Communicate with MicroCAT

The **S>** prompt indicates that communications between the MicroCAT and computer have been established. Before proceeding with troubleshooting, attempt to establish communications again by clicking **Connect** on SEATERM's toolbar or pressing the Enter key several times.

Cause/Solution 1: The I/O cable connection may be loose. Check the cabling between the MicroCAT and computer for a loose connection.

Cause/Solution 2: The instrument type and/or its communication settings may not have been entered correctly in SEATERM. Select the **SBE 37** in the **Configure** menu and verify the settings in the **Configuration Options** dialog box. The settings should match those on the instrument **Configuration Sheet**.

Cause/Solution 3: The I/O cable between the MicroCAT and computer may not be the correct one. The I/O cable supplied with the MicroCAT permits connection to standard 9-pin RS-232 interfaces.

Problem 2: No Data Recorded

Cause/Solution 1: The memory may be full; once the memory is full, no further data will be recorded. Verify that the memory is not full using **DS** (*free* = 0 or 1 if memory is full). Sea-Bird recommends that you upload all previous data before beginning another deployment. Once the data is uploaded, send **SampleNum=0** to reset the memory. After the memory is reset, **DS** will show *samplenum* = 0.

Problem 3: Unreasonable T, C, or P Data

The symptom of this problem is a data file that contains unreasonable values (for example, values that are outside the expected range of the data).

Cause/Solution 1: A data file with unreasonable (i.e., out of the expected range) values for temperature, conductivity, or pressure may be caused by incorrect calibration coefficients in the MicroCAT. Send **DC** to verify the calibration coefficients in the MicroCAT match the instrument Calibration Certificates. Note that calibration coefficients do not affect the raw data stored in MicroCAT memory. If you have not yet overwritten the memory with new data, you can correct the coefficients and then upload the data again.

Problem 4: Salinity Spikes

Salinity is a function of conductivity, temperature, and pressure, and must be calculated from C, T, and P measurements made on the same parcel of water. Salinity is calculated and output by the 37-SM if **OutputSal=Y**. Alternatively, salinity can be calculated in SBE Data Processing's Derive module from the data uploaded from memory (.cnv file).

*[Background information: Salinity spikes in **profiling** (i.e., moving, fast sampling) instruments typically result from misalignment of the temperature and conductivity measurements in conditions with sharp gradients. This misalignment is often caused by differences in response times for the temperature and conductivity sensors, and can be corrected for in post-processing if the T and C response times are known.]*

In **moored**, free-flushing instruments such as the 37-SM MicroCAT, wave action, mooring motion, and currents flush the conductivity cell at a faster rate than the environment changes, so the T and C measurements stay closely synchronized with the environment (i.e., even slow or varying response times are not significant factors in the salinity calculation). More typical causes of salinity spikes in a moored 37-SM include:

Cause/Solution 1: Severe external bio-fouling can restrict flow through the conductivity cell to such an extent that the conductivity measurement is significantly delayed from the temperature measurement.

Cause/Solution 2: For a MicroCAT moored at shallow depth, differential solar heating can cause the actual temperature inside the conductivity cell to differ from the temperature measured by the thermistor. Salinity spikes associated mainly with daytime measurements during sunny conditions may be caused by this phenomenon.

Cause/Solution 3: For a MicroCAT moored at shallow depth, air bubbles from breaking waves or spontaneous formation in supersaturated conditions can cause the conductivity cell to read low or correct.

Glossary

Battery pack – Six 9-volt (nominal 1.2 amp-hour) batteries, each containing lithium cells of the type commonly used in cameras. The battery pack also includes two small PCBs and a brass sleeve.

Convert – Toolbar button in SEATERM to convert ASCII (.asc) data uploaded with SEATERM to .cnv format. Once data is converted to .cnv format, SBE Data Processing can be used to analyze and display data.

Fouling – Biological growth in the conductivity cell during deployment.

MicroCAT – High-accuracy conductivity, temperature, and optional pressure recorder. A number of models are available:

- SBE 37-IM (**I**nductive **M**odem, internal battery and memory)
- SBE 37-IMP (**I**nductive **M**odem, internal battery and memory, integral **P**ump)
- SBE 37-SM (**S**erial interface, internal battery and **M**emory)
- SBE 37-SMP (**S**erial interface, internal battery and **M**emory, integral **P**ump)
- SBE 37-SI (**S**erial **I**nterface only, no internal battery or memory)
- SBE 37-SIP (**S**erial **I**nterface only, no internal battery or memory, integral **P**ump)

The -SM, -SMP, -SI, and -SIP are available with RS-232 (standard) or RS-485 (optional) interface.

PCB – Printed Circuit Board.

SBE Data Processing - Sea-Bird's Win 2000/XP data processing software, which calculates and plots temperature, conductivity, and optional pressure, and derives variables such as salinity and sound velocity.

Scan – One data sample (consisting of **NAvg** averaged measurements) containing temperature, conductivity, optional pressure, and optional date and time, as well as optional derived variables (salinity and sound velocity).

SEASOFT-Win32 – Sea-Bird's complete Win 2000/XP software package, which includes software for communication, real-time data acquisition, and data analysis and display. SEASOFT-Win32 includes *SEATERM* and *SBE Data Processing*.

SEATERM – Sea-Bird's Win 95/98/NT/2000/XP software used to communicate with the MicroCAT.

Super O-Lube – Silicone lubricant used to lubricate O-rings and O-ring mating surfaces. Super O-Lube can be ordered from Sea-Bird, but should also be available locally from distributors. Super O-Lube is manufactured by Parker Hannifin; see <http://www.parker.com/ead/cm2.asp?cmid=3956> for details.

TCXO – Temperature Compensated Crystal Oscillator.

Triton X-100 – Reagent grade non-ionic surfactant (detergent), used for cleaning the conductivity cell. Triton can be ordered from Sea-Bird, but should also be available locally from chemical supply or laboratory products companies. Triton is manufactured by Mallinckrodt Baker (see <http://www.mallinckrodt.com/changecountry.asp?back=/Default.asp> for local distributors).

Appendix I: Functional Description

Sensors

The MicroCAT embodies the same sensor elements (3-electrode, 2-terminal, borosilicate glass cell, and pressure-protected thermistor) previously employed in Sea-Bird's modular SBE 3 and SBE 4 sensors and in Sea-Bird's SEACAT family.

Note:

Pressure ranges are expressed in meters of deployment depth capability.

The MicroCAT's optional pressure sensor, developed by Druck, Inc., has a superior new design that is entirely different from conventional 'silicon' types in which the deflection of a metallic diaphragm is detected by epoxy-bonded silicon strain gauges. The Druck sensor employs a micro-machined *silicon diaphragm* into which the strain elements are implanted using semiconductor fabrication techniques. Unlike metal diaphragms, silicon's crystal structure is perfectly elastic, so the sensor is essentially free of pressure hysteresis. Compensation of the temperature influence on pressure offset and scale is performed by the MicroCAT's CPU. The pressure sensor is available in the following pressure ranges: 20, 100, 350, 600, 1000, 2000, 3500, and 7000 meters.

Sensor Interface

Temperature is acquired by applying an AC excitation to a hermetically sealed VISHAY reference resistor and an ultra-stable aged thermistor with a drift rate of less than 0.002°C per year. A 24-bit A/D converter digitizes the outputs of the reference resistor and thermistor (and optional pressure sensor). AC excitation and ratiometric comparison using a common processing channel avoids errors caused by parasitic thermocouples, offset voltages, leakage currents, and reference errors.

Conductivity is acquired using an ultra-precision Wien Bridge oscillator to generate a frequency output in response to changes in conductivity. A high-stability TCXO reference crystal with a drift rate of less than 2 ppm/year is used to count the frequency from the oscillator.

Real-Time Clock

To minimize battery current drain, a low power *watch* crystal is used as the real-time-clock frequency source. Initial error and ambient temperature-induced drift are compensated by measuring its actual frequency against the TCXO each time a reading of temperature and conductivity is made during calibration. The measured discrepancy (if any) is used to arithmetically correct the low power clock during normal operation.

Appendix II: Electronics Disassembly/Reassembly

Disassembly

CAUTION:

See *Section 5: Routine Maintenance and Calibration* for handling instructions for the plastic *ShallowCAT* housing.

1. Remove the end cap and battery pack following instructions in *Section 3: Preparing MicroCAT for Deployment*. **Do not remove the titanium guard!**
2. The electronics are on a sandwich of three rectangular PCBs. These PCBs are assembled to a bulkhead that can be seen at the bottom of the battery compartment. To remove the PCB assembly:
 - A. Use a long screwdriver (#1 screwdriver) to remove the Phillips-head screw at the bottom of the battery compartment. The Phillips-head screw is a 198 mm (7.8 inch) threaded rod with Phillips-head.
 - B. Pull out the PCB assembly using the PVC pylon (post with Molex connector). The assembly will pull away from the 10-position edge connector used to connect to the sensors.

Reassembly

Note:

If the rod will not tighten, the PCBs have not fully mated or are mated in reverse.

Note:

Before delivery, a desiccant package is inserted in the housing and the electronics chamber is filled with dry Argon gas. These measures help prevent condensation. To ensure proper functioning:

1. Install a new desiccant bag each time you open the electronics chamber. If a new bag is not available, see *Application Note 71: Desiccant Use and Regeneration (drying)*.
2. If possible, dry gas backfill each time you open the housing. If you cannot, wait at least 24 hours before redeploying, to allow the desiccant to remove any moisture from the housing.

Note that opening the battery compartment does not affect desiccation of the electronics.

1. Sight down into the MicroCAT housing to find the hole into which the Phillips-head screw threads. The hole is at the bottom of the housing, next to the edge connector. The small-diameter brass sleeve between two of the PCBs guides the screw into the hole. Align this sleeve with the hole.
2. Guide the PCB assembly into the housing and push the assembly until the edge connector is fully inserted. A gentle resistance can be felt during the last 3 mm ($\frac{1}{8}$ inch) of insertion as the PCB assembly mates to the edge connector.
3. Drop the Phillips-head screw into the hole and tighten gently.
4. If it is difficult to align the cards, obtain a 305mm (12 inch) length of 6-32 threaded rod.
 - A. Thread the end of this rod into the hole at the bottom of the housing (next to the edge connector).
 - B. Slide the PCB assembly's small diameter brass sleeve down the rod. The rod will help guide the assembly into the proper position.
 - C. Push the assembly until the edge connector is fully inserted. After the PCB assembly has been fully inserted, remove the rod.
 - D. Drop the Phillips-head screw into the hole and tighten gently.
5. Reinstall the battery pack and end cap following instructions in *Section 3: Preparing MicroCAT for Deployment*.

Appendix III: Command Summary

Note:

See *Command Descriptions* in *Section 4: Deploying and Operating MicroCAT* for detailed information and examples.

Note:

Do not set **Interval** to less than 10 seconds if transmitting real-time data (**TxRealTime=Y**).

CATEGORY	COMMAND	DESCRIPTION
Status	DS	Display status.
Setup	MMDDYY=mmddyy	Set real-time clock month, day, year. Follow with HHMMSS= or it will not set date.
	DDMMYY=ddmmyy	Set real-time clock day, month, year. Follow with HHMMSS= or it will not set date.
	HHMMSS=hhmmss	Set real-time clock hour, minute, second.
	Baud=x	x= baud rate (600, 1200, 2400, 4800, 9600, 19200, or 38400). Default 9600.
	OutputSal=x	x=Y: calculate and output salinity (psu) with each sample. x=N: do not.
	OutputSV=x	x=Y: calculate and output sound velocity (m/sec) with each sample. x=N: do not.
	Format=x	x=0: output raw hex data, for diagnostic use x=1: output converted data, date dd mmm yyyy x=2: output converted data, date mm-dd-yyyy
	RefPress=x	x= reference pressure (gauge) in decibars (used for conductivity computation when MicroCAT does not have pressure sensor).
	NAvg=x	x= number of measurements (1 – 1000) to take and average per sample. Default 1; larger values have a large impact on battery endurance.
	PumpInstalled=x	x=N: Internal pump is not installed (only valid setting for 37-SM) .
	SampleNum=x	x= sample number for first sample when sampling begins. After all previous data has been uploaded, set to 0 before starting to sample to make entire memory available for recording. If not reset to 0, data stored after last sample.
Autonomous Sampling (Logging)	QS	Enter quiescent (sleep) state. Main power turned off, but data logging and memory retention unaffected.
	Interval=x	x= interval (seconds) between samples (5 - 32767). When commanded to start sampling with StartNow or StartLater , at x second intervals MicroCAT takes sample consisting of NAvg measurements, stores averaged data in FLASH memory, transmits real-time averaged data (if TxRealTime=Y), and goes to sleep.
	StoreTime=x	x=Y: store date and time with each sample. x=N: do not.
	TxRealTime=x	x=Y: output real-time averaged data. x=N: do not.
	StartNow	Start logging now.
	StartMMDDYY=mmddyy	Delayed logging start: month, day, year. Must follow with StartHHMMSS= .
	StartDDMMYY=ddmmyy	Delayed logging start: day, month, year. Must follow with StartHHMMSS= .
	StartHHMMSS=hhmmss	Delayed logging start: hour, minute, second.
	StartLater	Start logging at delayed logging start time.
	Stop	Stop logging or stop waiting to start logging. Press Enter key to get S> prompt before entering Stop . Must send Stop before uploading data.

CATEGORY	COMMAND	DESCRIPTION
Polled (All samples consist of NAvg measurements; averaged data is stored and/or output as applicable.)	TS	Take sample, output converted data, and leave power on. Data not stored in FLASH memory.
	TSR	Take sample, output raw data, and leave power on. Data not stored in FLASH memory.
	TSS	Take sample, store in FLASH memory , output converted data, and turn power off.
	TSSOn	Take sample, store in FLASH memory , output converted data, and leave power on.
	SLT	Output converted data from last sample, then take new sample, and leave power on. Data not stored in FLASH memory.
	SLTR	Output raw data from last sample, then take new sample, and leave power on. Data not stored in FLASH memory.
	SL	Output converted data from last sample taken with either Polled Sampling or Logging Commands.
Serial Line Sync	SyncMode=x	x=Y : enable serial line sync mode. When RS-232 RX line is high (3-10 VDC) for 1-1000 milliseconds, MicroCAT takes a sample consisting of NAvg measurements, stores averaged data in FLASH memory, and transmits real-time averaged data. x=N : disable serial line sync mode.
	SyncWait=x	x = time (seconds) MicroCAT monitors RS-232 line for commands after executing take sample command. Range 0 - 120 seconds; default 0 seconds.
Data Upload	DDb,e	Upload data beginning with scan b, ending with scan e. Send Stop before sending DDb,e .
Testing	TT	Measure temperature 100 times or until Esc key is pressed, output converted data.
	TC	Measure conductivity 100 times or until Esc key is pressed, output converted data.
	TP	Measure pressure 100 times or until Esc key is pressed, output converted data.
	TTR	Measure temperature 100 times or until Esc key is pressed, output raw data.
	TCR	Measure conductivity 100 times or until Esc key is pressed, output raw data.
	TPR	Measure pressure 100 times or until Esc key is pressed, output raw data.
	TR	Measure real-time clock frequency 30 times or until Esc key is pressed, output data.

Note:
Use Upload on the Toolbar or Upload Data in the Data menu to upload data that will be processed by SBE Data Processing. Manually entering **DDb,e** does not produce data with the required header information for processing by SBE Data Processing.

CATEGORY	COMMAND	DESCRIPTION
Coefficients (F=floating point number; S=string with no spaces) Dates shown are when calibrations were performed. Calibration coefficients are initially factory-set and should agree with Calibration Certificates shipped with MicroCAT.	DC	Display calibration coefficients; all coefficients and dates listed below are included in display. Use individual commands below to modify a particular coefficient or date.
	TCalDate=S	S=Temperature calibration date.
	TA0=F	F=Temperature A0.
	TA1=F	F=Temperature A1.
	TA2=F	F=Temperature A2.
	TA3=F	F=Temperature A3.
	CCalDate=S	S=Conductivity calibration date.
	CG=F	F=Conductivity G.
	CH=F	F=Conductivity H.
	CI=F	F=Conductivity I.
	CJ=F	F=Conductivity J.
	WBOTC=F	F=Conductivity wbotc.
	CTCOR=F	F=Conductivity ctcor.
	CPCOR=F	F=Conductivity cpcor.
	PCalDate=S	S=Pressure calibration date.
	PA0=F	F=Pressure A0.
	PA1=F	F=Pressure A1.
	PA2=F	F=Pressure A2.
	PTCA0=F	F=Pressure ptca0
	PTCA1=F	F=Pressure ptca1.
	PTCA2=F	F=Pressure ptca2.
	PTCB0=F	F=Pressure ptcb0.
	PTCB1=F	F=Pressure ptcb1.
	PTCB2=F	F=Pressure ptcb2.
	POffset=F	F=Pressure offset.
	RCalDate=S	S=Real-time clock calibration date.
	RTCA0=F	F=Real-time clock A0.
	RTCA1=F	F=Real-time clock A1.
	RTCA2=F	F=Real-time clock A2.

Appendix IV: AF24173 Anti-Foulant Device

AF24173 Anti-Foulant Devices supplied for user replacement are supplied in polyethylene bags displaying the following label:

AF24173 ANTI-FOULANT DEVICE

FOR USE ONLY IN SEA-BIRD ELECTRONICS' CONDUCTIVITY SENSORS TO CONTROL THE GROWTH OF AQUATIC ORGANISMS WITHIN ELECTRONIC CONDUCTIVITY SENSORS.

ACTIVE INGREDIENT:

Bis(tributyltin) oxide..... 53.0%

OTHER INGREDIENTS: 47.0%

Total..... 100.0%

DANGER

See the complete label within the Conductivity Instrument Manual for Additional Precautionary Statements and Information on the Handling, Storage, and Disposal of this Product.

Net Contents: Two anti-foulant devices

Sea-Bird Electronics, Inc.
1808 - 136th Place Northeast
Bellevue, WA 98005

EPA Registration No. 74489-1
EPA Establishment No. 74489-WA-1

AF24173 Anti-Foulant Device

FOR USE ONLY IN SEA-BIRD ELECTRONICS' CONDUCTIVITY SENSORS TO CONTROL THE GROWTH OF AQUATIC ORGANISMS WITHIN ELECTRONIC CONDUCTIVITY SENSORS.

ACTIVE INGREDIENT:

Bis(tributyltin) oxide..... 53.0%
 OTHER INGREDIENTS: 47.0%
 Total..... 100.0%

DANGER

See Precautionary Statements for additional information.

FIRST AID	
If on skin or clothing	<ul style="list-style-type: none"> • Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15-20 minutes. • Call a poison control center or doctor for treatment advice.
If swallowed	<ul style="list-style-type: none"> • Call poison control center or doctor immediately for treatment advice. • Have person drink several glasses of water. • Do not induce vomiting. • Do not give anything by mouth to an unconscious person.
If in eyes	<ul style="list-style-type: none"> • Hold eye open and rinse slowly and gently with water for 15-20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. • Call a poison control center or doctor for treatment advice.
HOT LINE NUMBER	
Note to Physician	Probable mucosal damage may contraindicate the use of gastric lavage.
Have the product container or label with you when calling a poison control center or doctor, or going for treatment. For further information call National Pesticide Telecommunications Network (NPTN) at 1-800-858-7378.	

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PRECAUTIONARY STATEMENTS**HAZARD TO HUMANS AND DOMESTIC ANIMALS****DANGER**

Corrosive - Causes irreversible eye damage and skin burns. Harmful if swallowed. Harmful if absorbed through the skin or inhaled. Prolonged or frequently repeated contact may cause allergic reactions in some individuals. Wash thoroughly with soap and water after handling.

PERSONAL PROTECTIVE EQUIPMENT**USER SAFETY RECOMMENDATIONS**

Users should:

- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Wear protective gloves (rubber or latex), goggles or other eye protection, and clothing to minimize contact.
- Follow manufacturer's instructions for cleaning and maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.
- Wash hands with soap and water before eating, drinking, chewing gum, using tobacco or using the toilet.

ENVIRONMENTAL HAZARDS

Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans, or other waters unless in accordance with the requirements of a National Pollutant Discharge Elimination System (NPDES) permit and the permitting authority has been notified in writing prior to discharge. Do not discharge effluent containing this product to sewer systems without previously notifying the local sewage treatment plant authority. For guidance contact your State Water Board or Regional Office of EPA. This material is toxic to fish. Do not contaminate water when cleaning equipment or disposing of equipment washwaters.

PHYSICAL OR CHEMICAL HAZARDS

Do not use or store near heat or open flame. Avoid contact with acids and oxidizers.

DIRECTIONS FOR USE

It is a violation of Federal Law to use this product in a manner inconsistent with its labeling. For use only in Sea-Bird Electronics' conductivity sensors. Read installation instructions in the applicable Conductivity Instrument Manual.

STORAGE AND DISPOSAL

PESTICIDE STORAGE: Store in original container in a cool, dry place. Prevent exposure to heat or flame. Do not store near acids or oxidizers. Keep container tightly closed.

PESTICIDE SPILL PROCEDURE: In case of a spill, absorb spills with absorbent material. Put saturated absorbent material to a labeled container for treatment or disposal.

PESTICIDE DISPOSAL: Pesticide that cannot be used according to label instructions must be disposed of according to Federal or approved State procedures under Subtitle C of the Resource Conservation and Recovery Act.

CONTAINER DISPOSAL: Dispose of in a sanitary landfill or by other approved State and Local procedures.

Appendix V: Replacement Parts

Part Number	Part	Application Description	Quantity in MicroCAT
50243 / 50243.1	Lithium battery set (6 sticks)	Power MicroCAT	1
801542	AF24173 Anti-Foulant Device	Bis(tributyltin) oxide device inserted into anti-foulant device cup	1 (set of 2)
231459	Anti-foulant device cup	Holds AF24173 Anti-Foulant Device	2
231505	Anti-foulant device cap	Secures AF24173 Anti-Foulant Device in cup	2
30984	Plug	Seals end of anti-foulant cap when not deployed, keeping dust and aerosols out of conductivity cell during storage	2
30411	Triton X-100	Octyl Phenol Ethoxylate – Reagent grade non-ionic cleaning solution for conductivity cell (supplied in 100% strength; dilute as directed)	-
50087.1	Conductivity cell filling & storage device with hose barb caps	For cleaning and storing conductivity cell	-
801412	3-pin RMG-3FS to 9-pin DB-9S I/O cable, 2.4 m (8 ft)	From MicroCAT to computer	1
801385	4-pin RMG-4FS to 9-pin DB-9S I/O cable with power leads, 2.4 m (8 ft)	From MicroCAT (with optional external power) to computer	1
17043	Locking sleeve (for RMG)	Locks cable/plug in place	1
17045.1	3-pin RMG-3FSD-LP dummy plug with locking sleeve	For when cable not used	1
17046.1	4-pin RMG-4FSD-LP dummy plug with locking sleeve	For when cable not used	1
801366	3-pin MCIL-3FS (wet-pluggable connector) to 9-pin DB-9S I/O cable, 2.4 m (8 ft)	From MicroCAT to computer	1
801206	4-pin MCIL-4FS (wet-pluggable connector) to 9-pin DB-9S I/O cable with power leads, 2.4 m (8 ft)	From MicroCAT (with optional external power) to computer	1
171192	Locking sleeve (wet-pluggable connector)	Locks cable/plug in place	1
171500.1	3-pin MCDC-3-F dummy plug with locking sleeve, wet-pluggable connector	For when cable not used	
171398.1	4-pin MCDC-4-F dummy plug with locking sleeve, wet-pluggable connector	For when cable not used	1
171888	25-pin DB-25S to 9-pin DB-9P cable adapter	For use with computer with DB-25 connector	1

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Part Number	Part	Application Description	Quantity in MicroCAT
30507	Parker 2-206N674-70 O-ring	O-ring between end of conductivity cell and anti-foulant device cup	2
60035	37-SM / -SMP spare hardware/ O-ring kit	<p>Assorted hardware and O-rings, including:</p> <ul style="list-style-type: none"> • 30900 Machine screw, 1/4-20 x 2" hex head, titanium (secures mounting clamp) • 30633 Washer, 1/4" split ring lock, titanium (for screw 30900) • 30634 Washer 1/4" flat, titanium (for screw 30900) • 31019 O-ring 2-008 N674-70 (for screw 30900 – retains mounting clamp hardware) • 31040 Screw, 8-32 x 1 FH, TI (secures cable guide base to I/O connector end cap) • 30860 Screw, 6-32 x 1/2 FH TI (secures cable clamp half to flat area of sensor end cap) • 30544 Screw 8-32 x 1/2 FH, titanium (secures cell guard to housing) • 30859 Screw, 8-32 x 3/8" FH, PH, titanium (secures housing to I/O connector end cap) • 30857 Parker 2-033E515-80 O-ring (I/O connector end cap and sensor end cap O-ring) • 30149 Screw, 6-32 x 5/8 PH, stainless steel (secures battery pack assembly to battery pylon) • 30243 Washer, #6 split ring lock, stainless steel (for screw 30149) • 30357 Screw, 2-56 x 1/4 PH, stainless steel (secures battery pack's upper PCB to brass sleeve) • 30986 Washer, #2 split ring lock, stainless steel (for screw 30357) 	-

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